CONCRETE
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CONSTRUCTIONAL ENGINEERING

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MARCH, 1955. **Vol. L, No. 3**

FIFTIETH YEAR OF PUBLICATION

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These illustrations are of 12in. x 6in. concrete cylinders, mixed 4-2-1 with water/cement ratio of 0.6 made to Code of Practice. For the left-hand cylinder in each case ordinary Portland Cement was used and for the right-hand cylinder, Sulphate-Resisting Cement. The cylinders in A were immersed in magnesium sulphate solution where the equivalent SO_3 content is 500 parts per 100,000. The cylinders shown in B were immersed in a sodium sulphate solution of similar SO_3 content. **The photographs were taken after the cylinders had been immersed for five years.** The value of using Sulphate-Resisting Cement for concrete work which is liable to the destructive action of soluble sulphates is clearly indicated since on the majority of sites the sulphate concentration seldom exceeds the equivalent SO_3 content of the solution used for the test.

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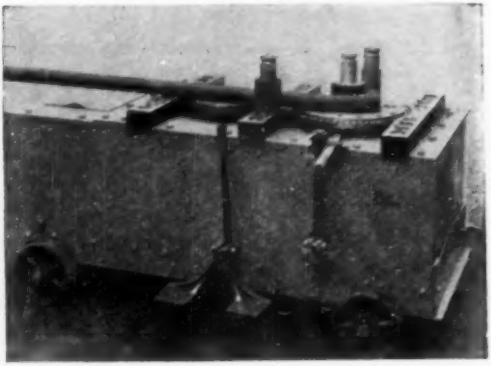

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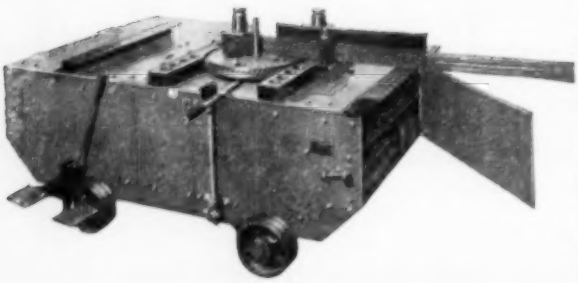

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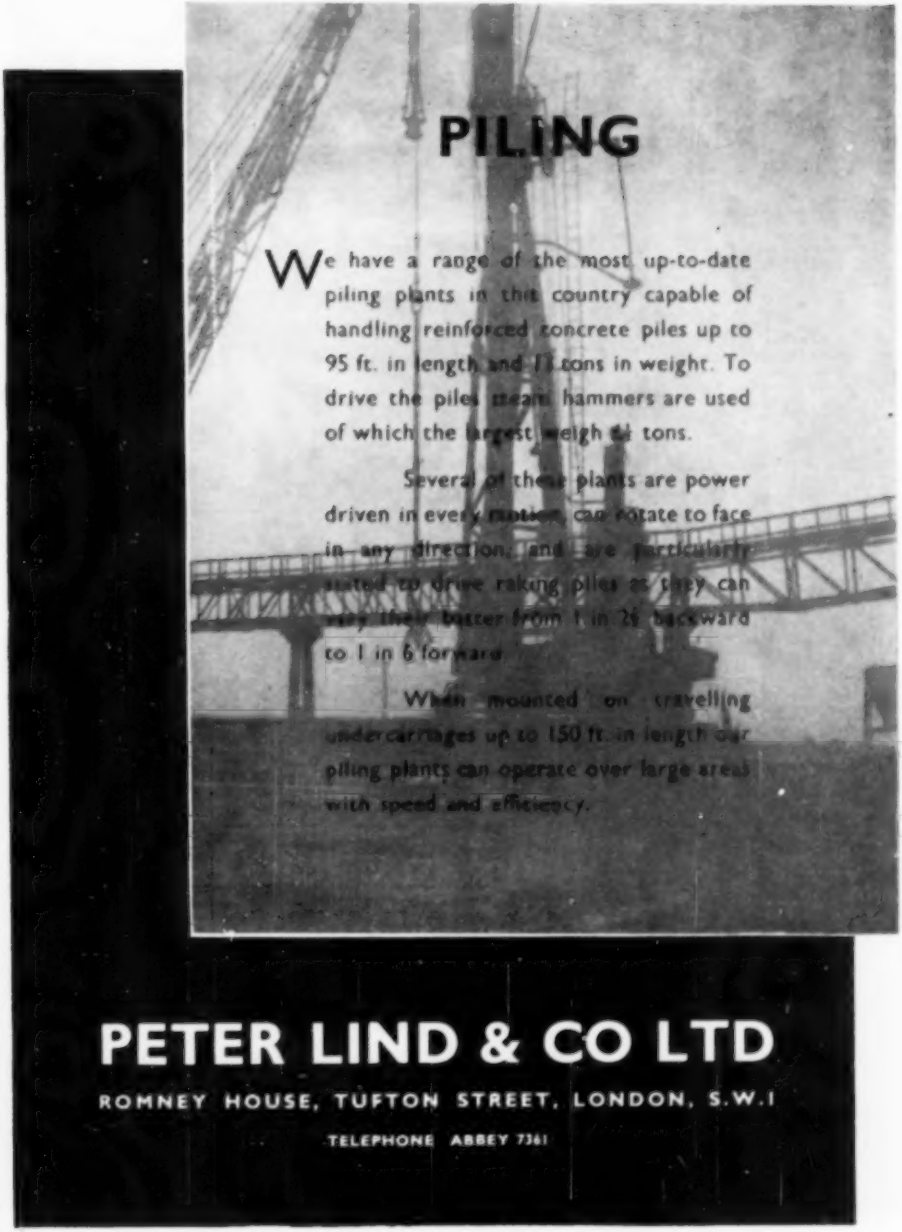
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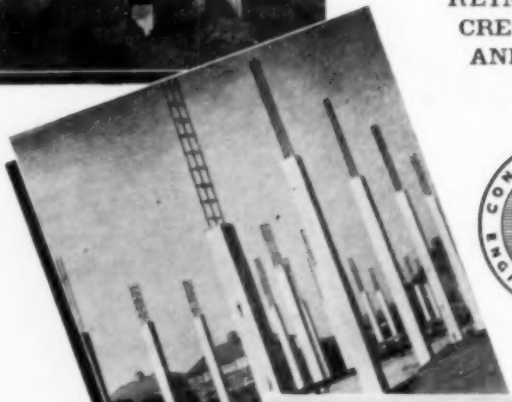

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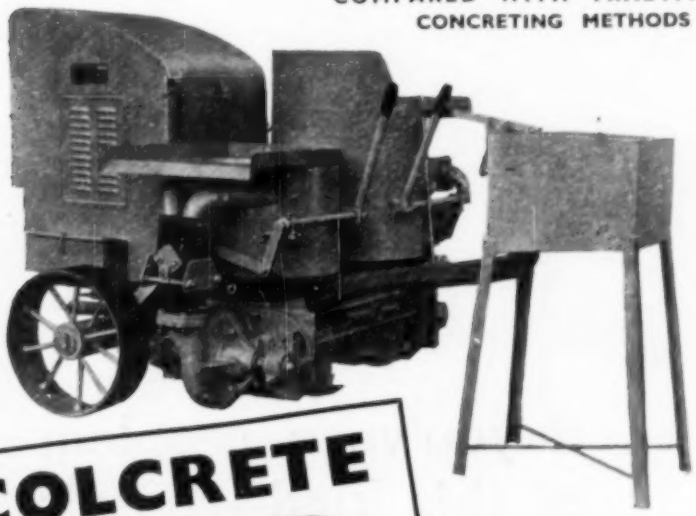

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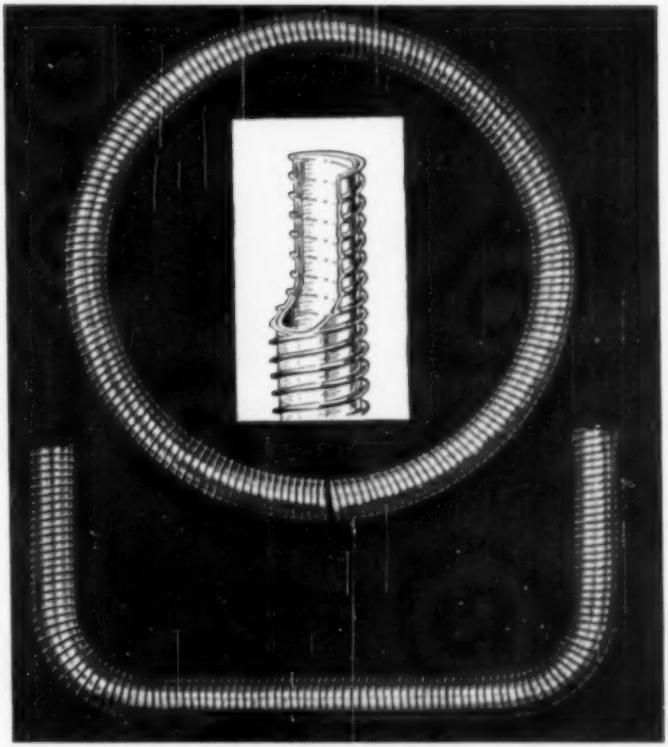

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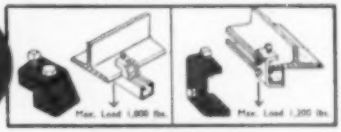

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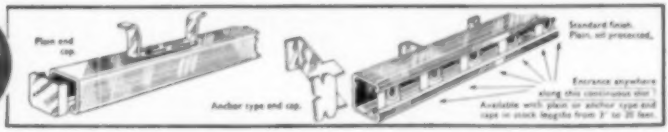
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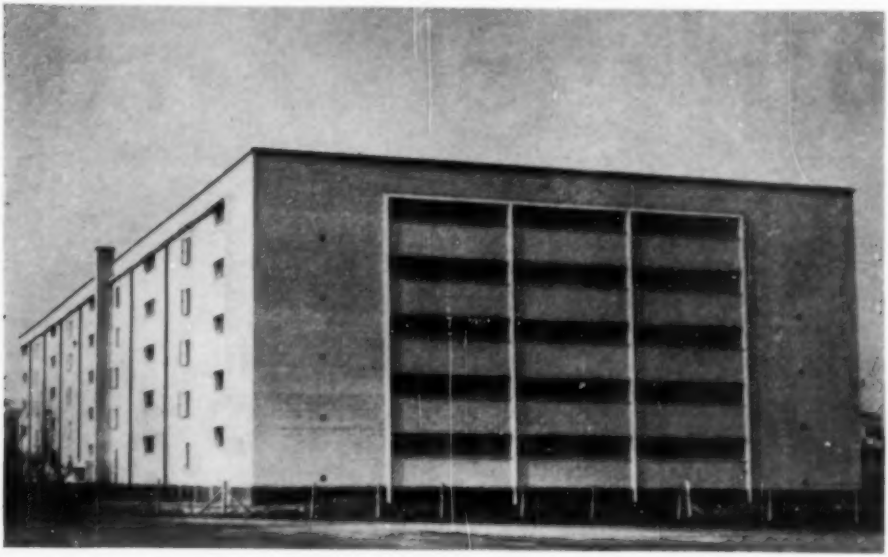

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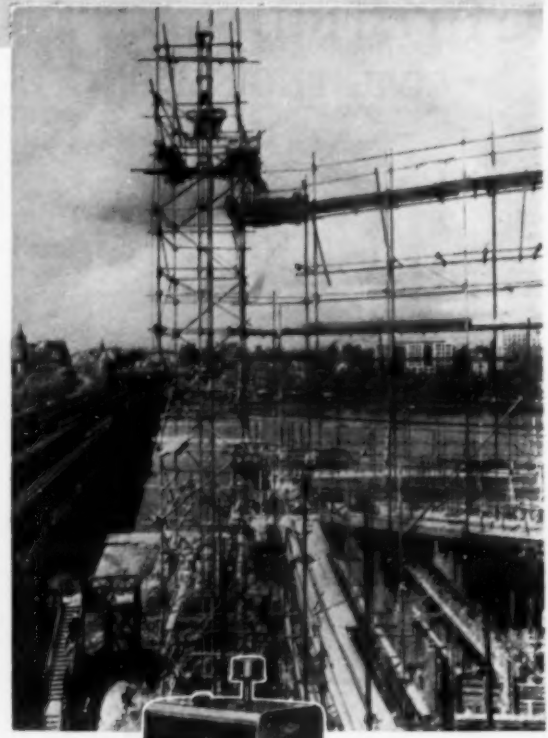

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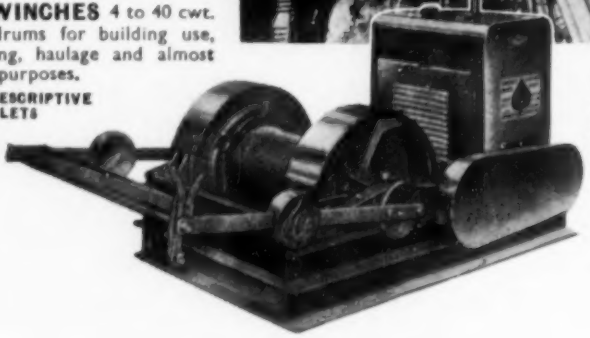

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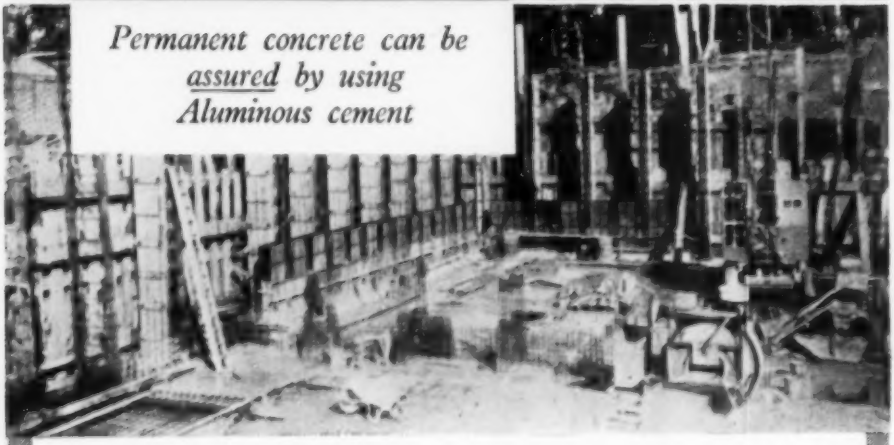

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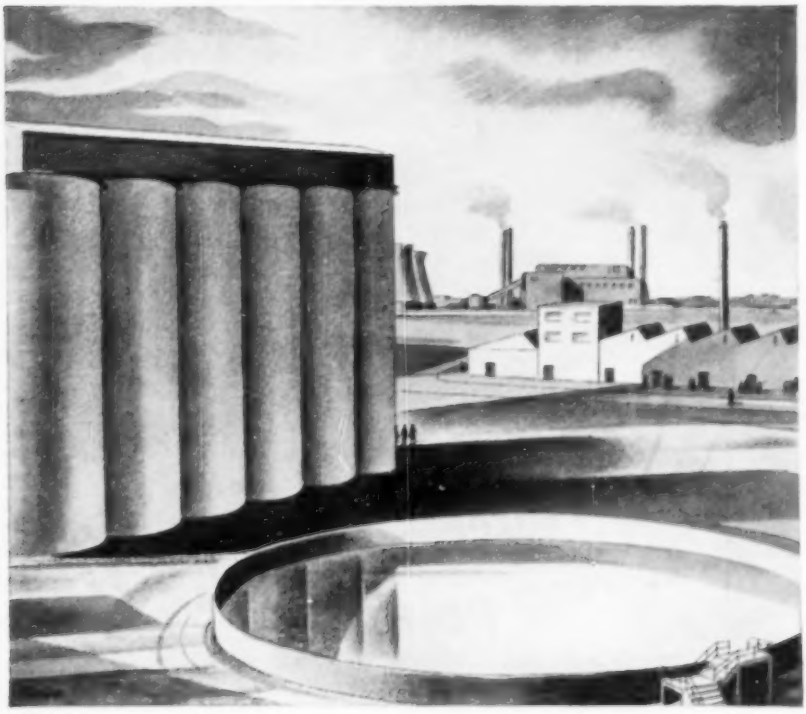

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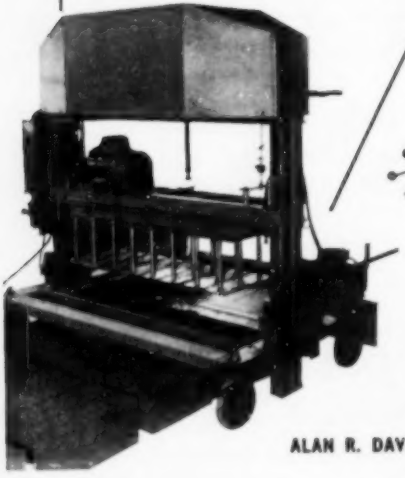

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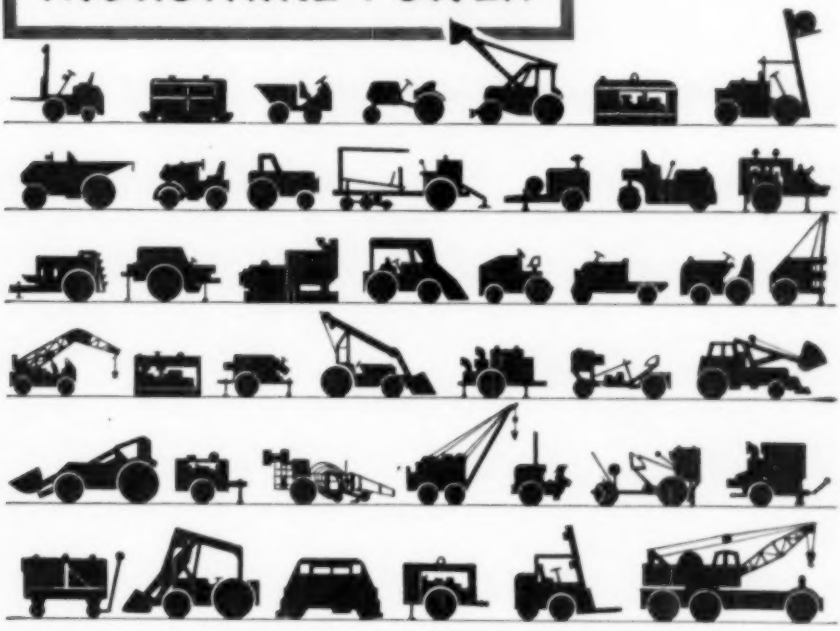

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1800 ,,	10	14	20·4	29	40·75	–	–	38	50
2000 ,,	11	15·6	22·4	32	45·6	–	–	–	54
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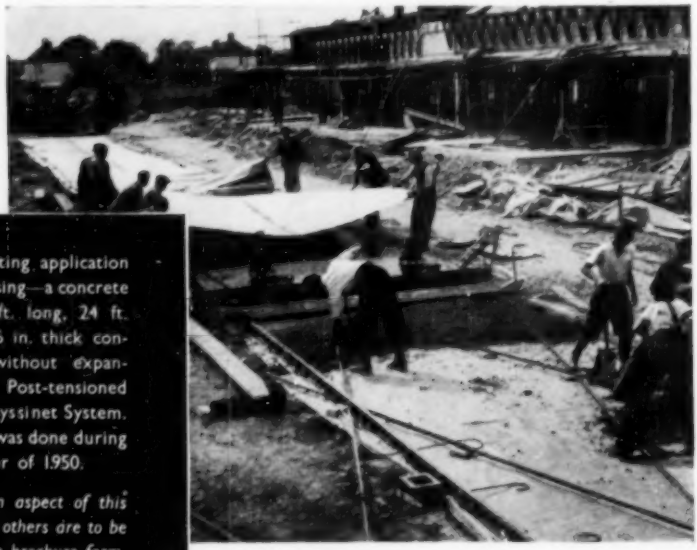

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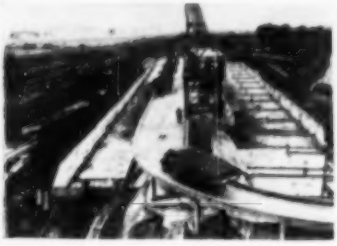

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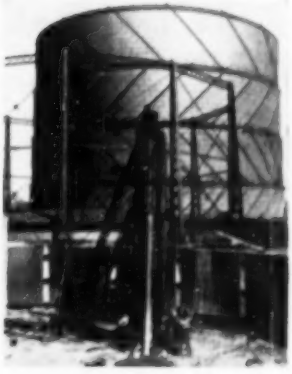

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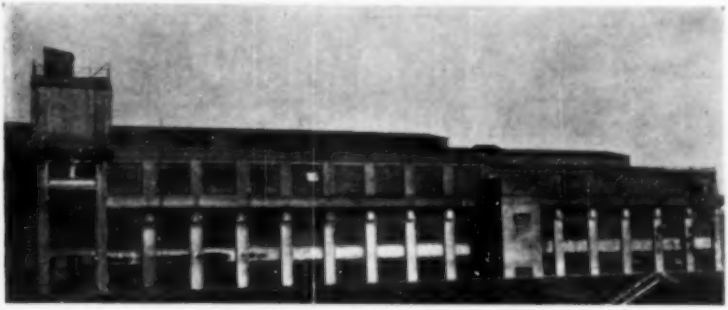
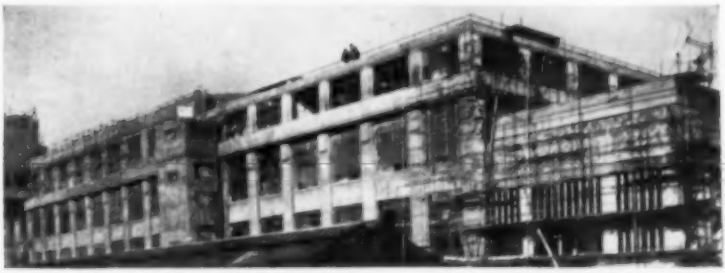


AFTER RENOVATION



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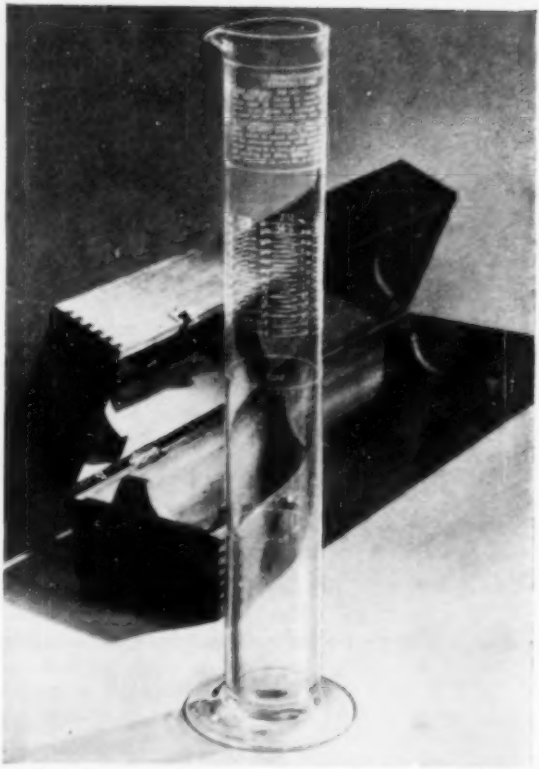

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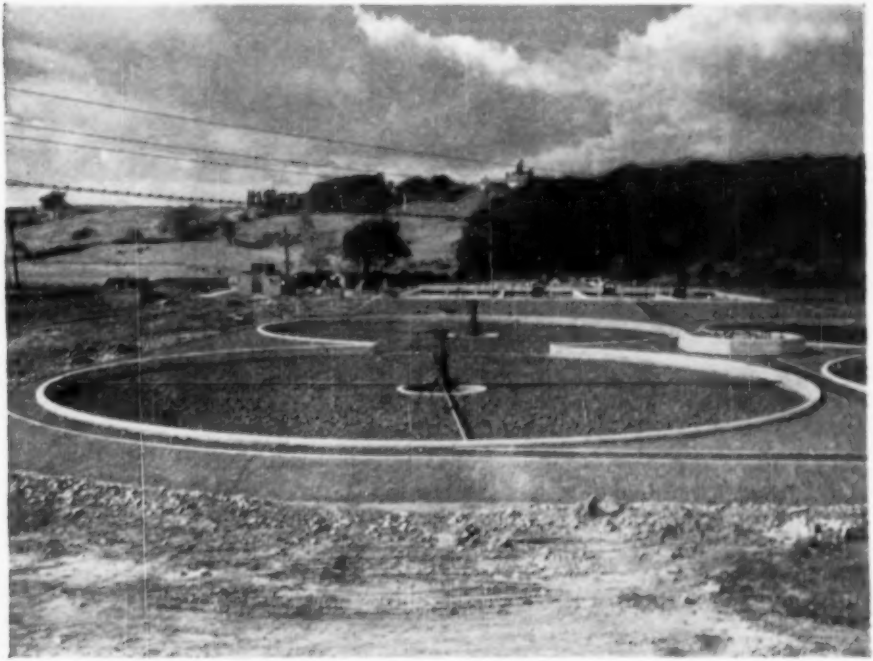

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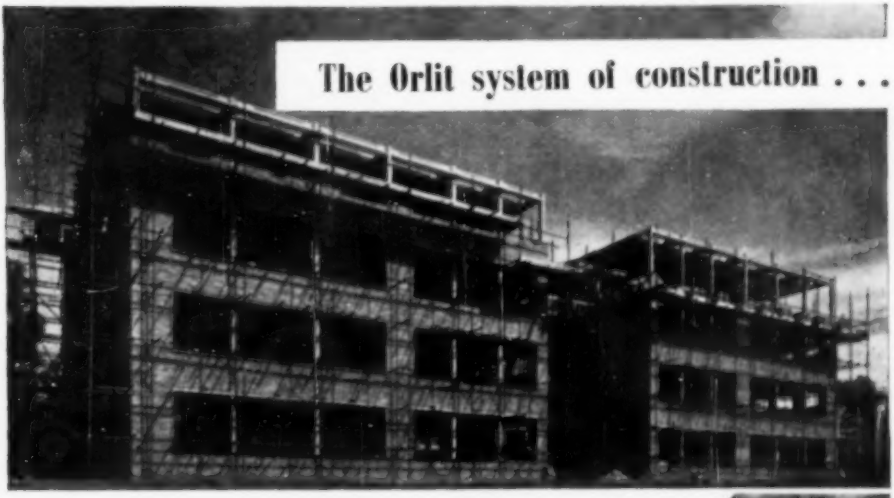

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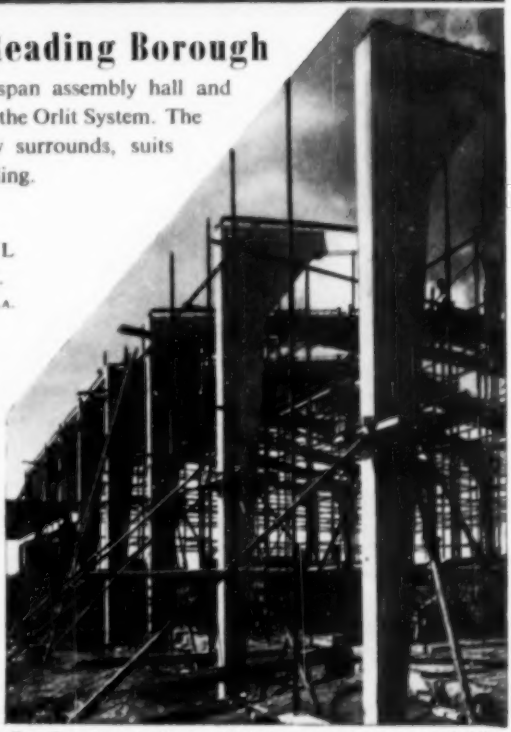

Top. Front elevation 4-storey block showing traditional brick cladding and Orlit structural framework (upper storey); window surrounds by Orlit.
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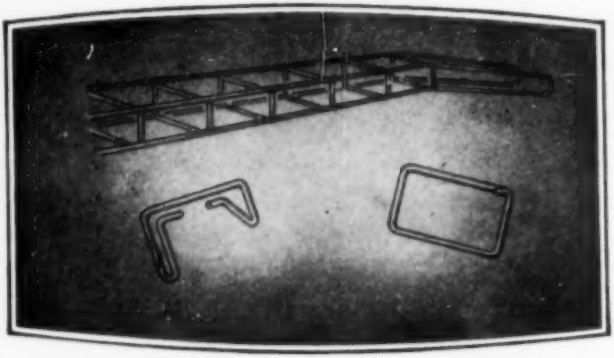

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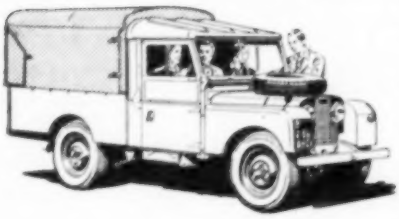

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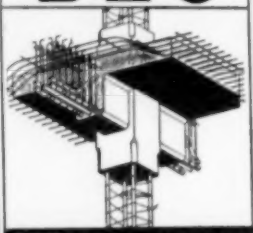

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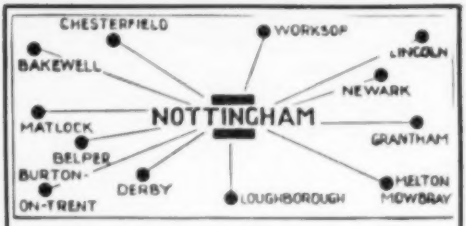

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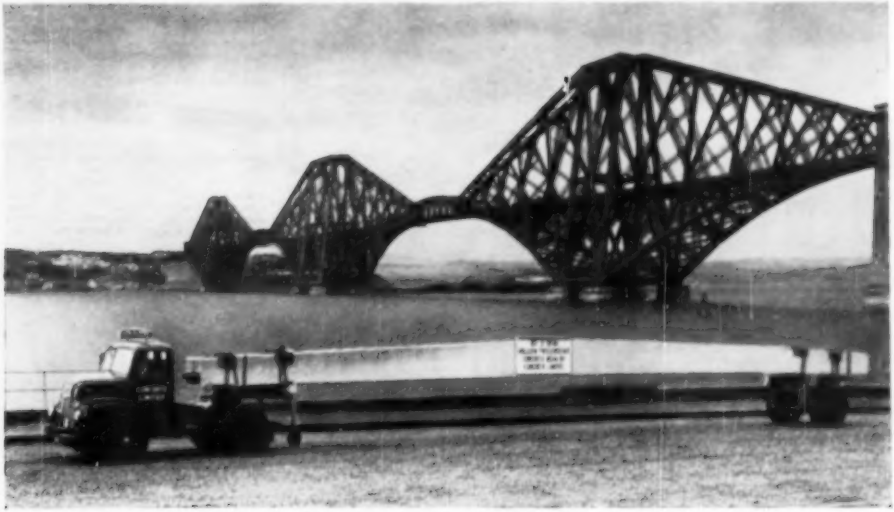

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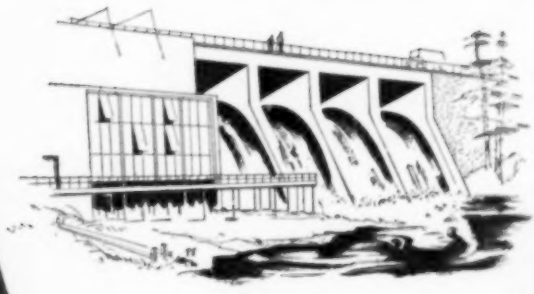

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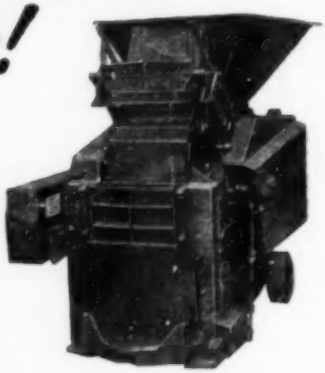

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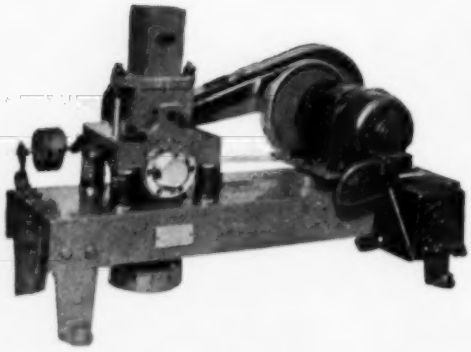

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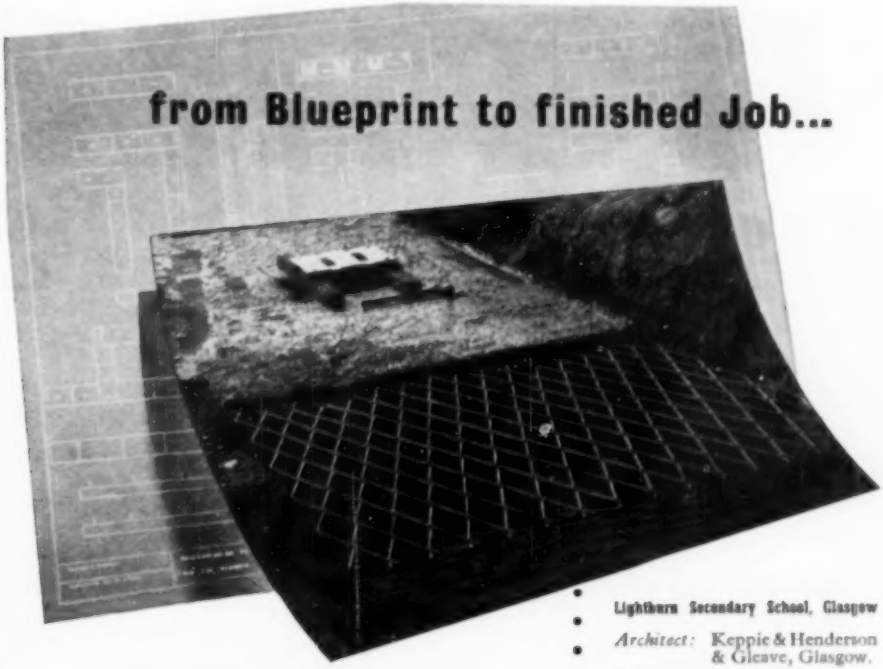

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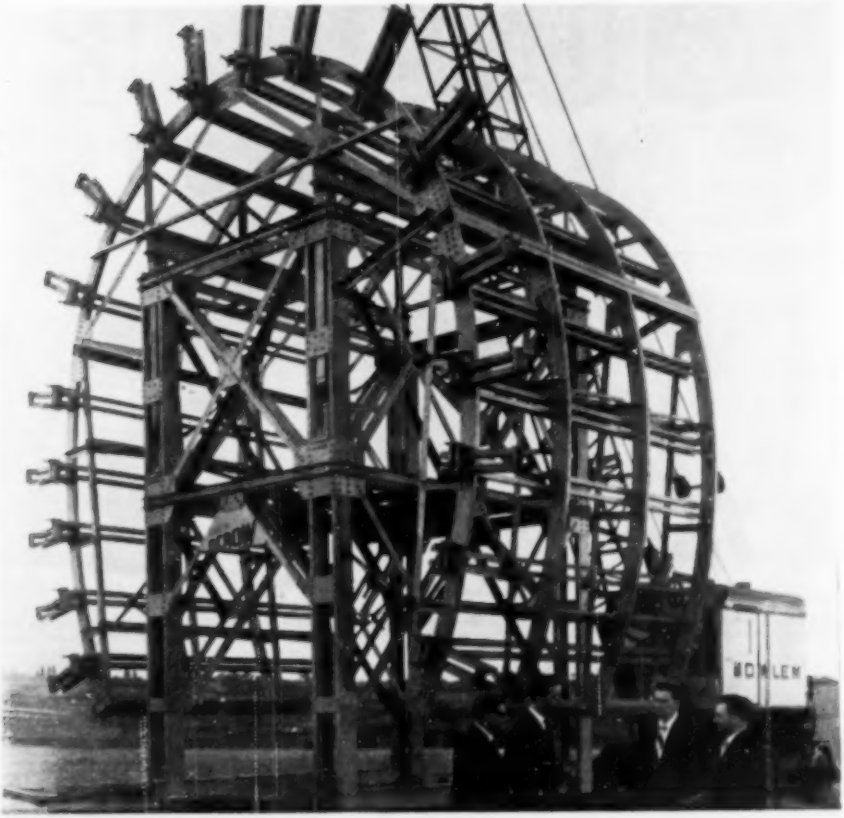

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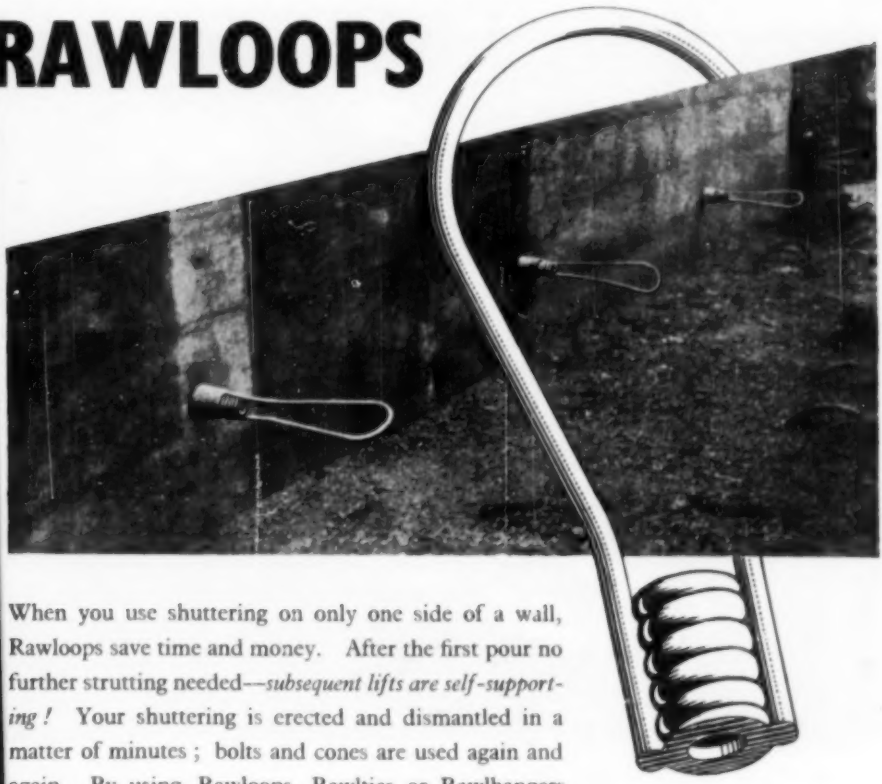

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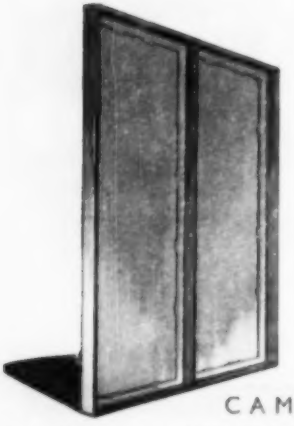

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Volume L, No. 3. LONDON, MARCH, 1955.

EDITORIAL NOTES

A Programme for Roads.

THE proposals of the Government to start making more of our roads suitable for modern requirements and to build new motor-roads will be generally welcomed. During recent years few new roads have been built, and most of the total annual expenditure on roads of about £100,000,000 has been used for the minor improvement and maintenance of existing roads. The value of this work should not be overlooked, for it is probably the major factor in the reduction of road accidents. Compared with the year 1938 there are now about twice as many vehicles on the roads, and yet fewer people are killed in road accidents. This is a remarkable achievement, which clearly demonstrates the value of making the present roads safer. During the next four years the extra contribution of the Government is to be more than doubled to a total of £147,000,000, making the total expenditure of the Government and local authorities an average of about £137,000,000 a year. The improvement of existing roads has also shortened the time of many journeys, although this is of little help to industry while the present absurd restriction to a speed of twenty miles an hour for heavy goods vehicles is in force.

Of the proposed new motor-roads, the work scheduled to be started first is a new road from London to Yorkshire, and the only indication of when this is to be started is a statement that the first section, from St. Albans to Rugby, " should be ready for commitment towards the end of the [four-years'] period ". This section, about 70 miles long, is estimated at present prices to cost about £211,000 per mile, and a similar road between Preston and Birmingham is estimated to cost £250,000 per mile. What the cost will be if the work is done in the 1960's according to the programme is, of course, quite unknown. These roads are to be motor roads only. The section from St. Albans to Rugby will have dual carriageways each 36 ft. wide, and from it no access to premises will be allowed. At all important crossings, and at other crossings where possible, the motor-road will cross the other roads by means of a bridge, and access to it from the other roads will be by means of curved roads entering the motor-road at an acute angle in the direction of the traffic on the motor-road. The plan is shown on page 128. At other junctions roundabouts may be built. Towns will be by-passed. It is fortunate that there is now a great deal of experience abroad on which to base the plans for these new roads, and it is notable that the expensive " clover-leaf " junctions that have been popular abroad have not been adopted. The " clover-leaf "

arrangement gives access to the motor-road from both sides of the road that is passed over, and it is no doubt sensibly decided that the extra cost is not justified when set against the extra distance that has to be travelled when access to the motor-road is from one side only of the minor roads. Other works scheduled to be authorised during the next four years include a crossing of the Firth of Forth, a tunnel under the river Thames between Dartford and Purfleet, the rebuilding of Albert bridge across the Thames, by-passes at Maidstone, Maidenhead, and elsewhere, and the improvement of some of the most congested crossings and streets in London.

In the conditions existing in Great Britain to-day the Government is perhaps fortunate that nearly four years will elapse before the first section of the programme of new roads may be started. The country has what is somewhat euphemistically called " full employment " ; this does not necessarily mean that all the nation is working hard, but it does mean that there is no reserve of men available to work on new roads. The new roads are planned to be in progress at the same time as the scheme for the reconstruction of the railways and the construction of nuclear power stations, but there is every indication that in four years' time ample supplies of cement and steel will be available due to the smaller requirements for fuel-burning power stations and airfields and to new cement and steel works coming into production. On the problem of labour, the President of the Federation of Civil Engineering Contractors is optimistic in view of the developments in labour-saving machinery. A hundred miles of motor-roads might, for example, require the moving of ten million tons of earth, which may be compared with a total of, say, 250 million tons of earth that are moved in this country each year. Two men with a small excavator can move as much earth as fifty men with picks and shovels and barrows, and there have been great developments in machinery for preparing foundations and laying concrete road slabs and surfaces. For providing foundations by the soil-cement process machines are available that lift the soil, pulverise it, mix it with cement, replace the mixture, and compact it at the rate of 200 linear yards a day for a carriageway 27 ft. wide. A modern machine can spread, compact, and finish a concrete road slab 27 ft. wide at a rate of about 350 linear yards a day, and in a large machine concrete can be proportioned by weight and mixed at a rate of 200 tons an hour. It may be recalled that during the war the area of the aircraft runways laid in Great Britain for the British and U.S.A. Air Forces were equivalent to about three thousand miles of dual-carriageway roads. However, the Minister has said that the amount of work to be authorised must depend upon the resources available and on the financial condition of the country at the time.

It is hoped that within the next four years a start will be made to provide a crossing of the Firth of Forth for road vehicles. Because much of the river bed is rock, little consideration has been given to the provision of a tunnel between North and South Queensferry, and the high cost of a bridge (about £15,000,000) and the large quantities of steel it would require have always in the past resulted in the provision of this much-needed crossing being postponed. An interesting proposal for the construction across the firth of a submerged reinforced concrete subway carried on piles has been submitted to the authorities as an alternative that it is estimated could be built at about one-third of the cost of a bridge, and is described on page 128 of this number.

Prestressed Concrete Slab Bridges with Stiffened Edges.

By ANDREW GALLIA, A.M.I.E. Australia.

THE design described in this article consists of prestressed precast slabs placed side by side with provision for lateral prestressing (*Fig.* 1). Kerbs or footpaths can be used as edge-beams and may be made of slabs with a cast-in-situ topping. The topping and the slabs may be held together by mechanical bonds such as castellations. After lateral prestressing the slab and edge-beams act together as a slab with stiffened edge members and constitute the complete load-carrying superstructure of a bridge. This type of bridge is especially suitable for spans up to 50 ft., where the ratio of width to span is equal to or greater than 0·6.

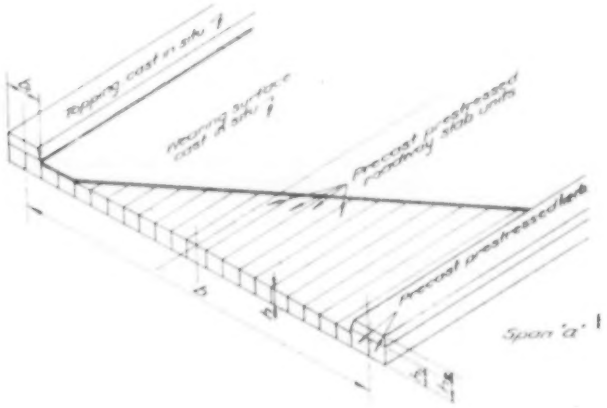
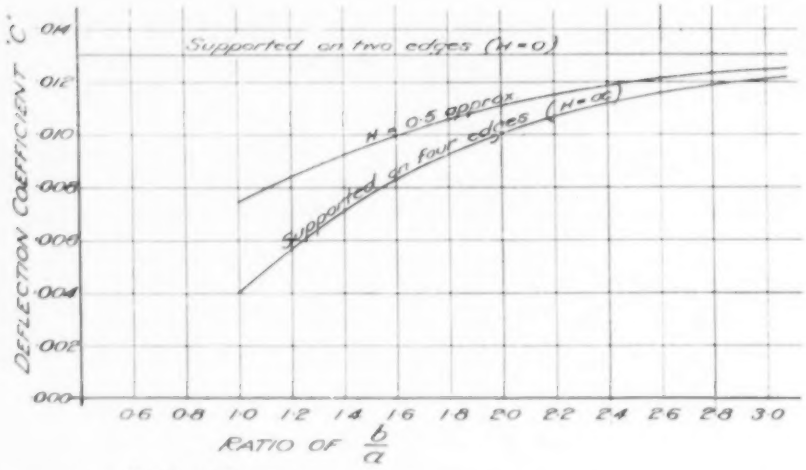


Fig. 1.

The method of design given is a continuation of the writer's articles on slab bridges in this journal for December, 1952, and October, 1953.

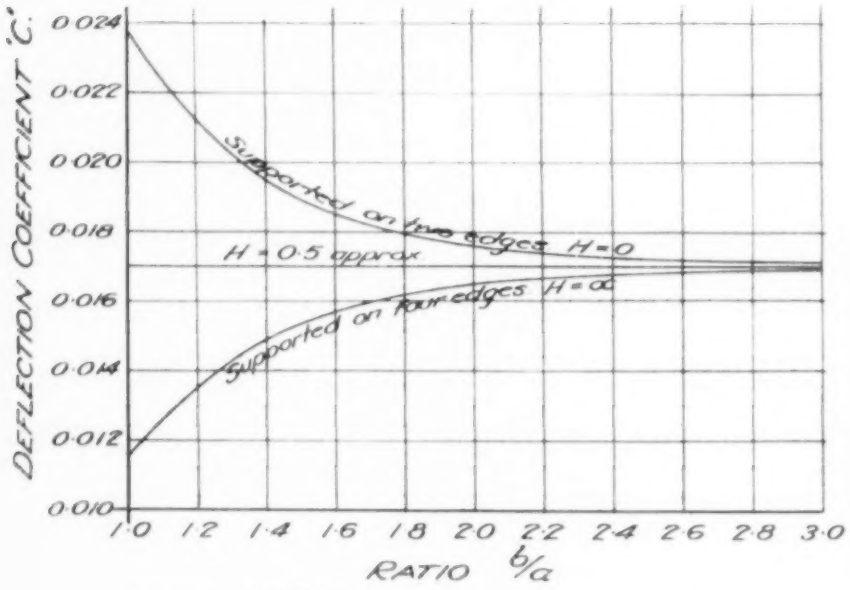
NOTATION.

a, Effective span of slab.
b, Width of slab, distance from centre to centre of stiffened edge-beams. b_1, Width of edge-beam.
h, Average thickness of the slab. h_1, Height of edge-beam before the topping is added. h_2, Height of edge-beam after the topping has been added.
c, Diameter of circular area on which a wheel load is assumed to act: 1·25 ft.
μ, Poisson's ratio, assumed to be 0·15.
N, Measure of stiffness of the slab: $N = \dfrac{E \times h^3}{12(1-\mu^2)}$.
H, Stiffness-factor of edge-beam and deck slab.
E, Modulus of elasticity of the material of the slab.
n_1, Modular ratio for cast-in-situ concrete.
n_2, Modular ratio for prestressed precast concrete.
P, Wheel load assumed to act on a circular area of diameter c.



Deflection $= \frac{C \times p \times a^4}{N}$. N = stiffness of slab. p = distributed load per unit area.

Fig. 2A.—Deflection at Centre of Simply-supported Rectangular Slabs due to Uniformly-distributed Loads.



Deflection $= \frac{C \times P \times a}{N}$. P = concentrated load. N = stiffness.

Fig. 2B.—Deflection of Centrally-loaded Rectangular Slabs.

p, Distributed load per unit area of deck slab.
q, Load per unit length of edge-beam.
f, Calculated stress in the concrete. f_b, Allowable compressive stress in concrete when the concrete is prestressed. f_t, Allowable compressive stress in concrete at working load.
t, Tensile stress in prestressing wires at working load.
A, Cross-sectional area of member.
I, Moment of inertia.
Z, Modulus of section.
M, Bending moment.
C, Deflection or bending moment coefficients.

The main advantages of this type of structure are (1) A reduction of the bending moment at midspan of the slab because of the stiffening effect of the edge-beams; (2) Easy transport and handling of the members; (3) A smaller deflection of the slab results in a smaller slenderness ratio and allows its thickness to be reduced.

Fig. 2A gives the deflections due to uniformly-distributed loads and *Fig.* 2B the deflections due to a concentrated load for the cases of a slab supported on

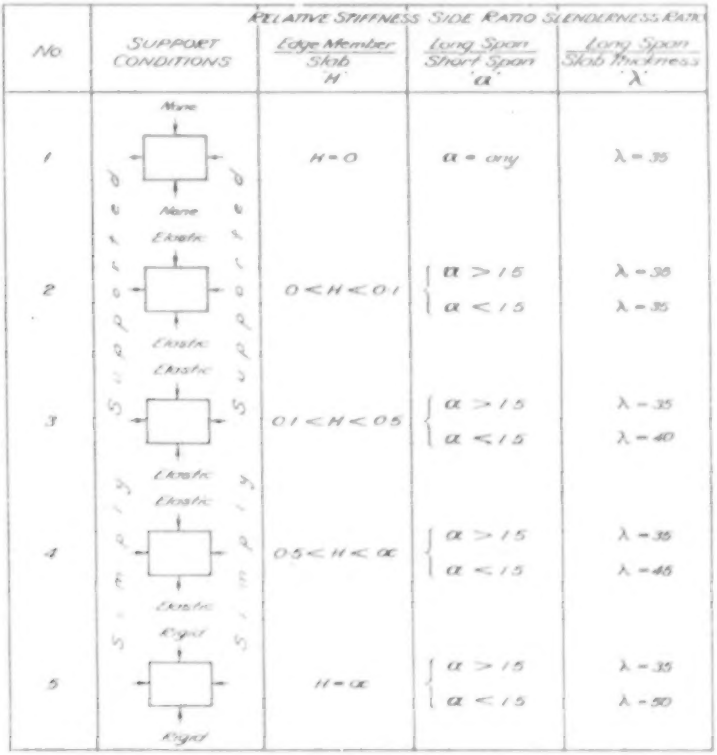
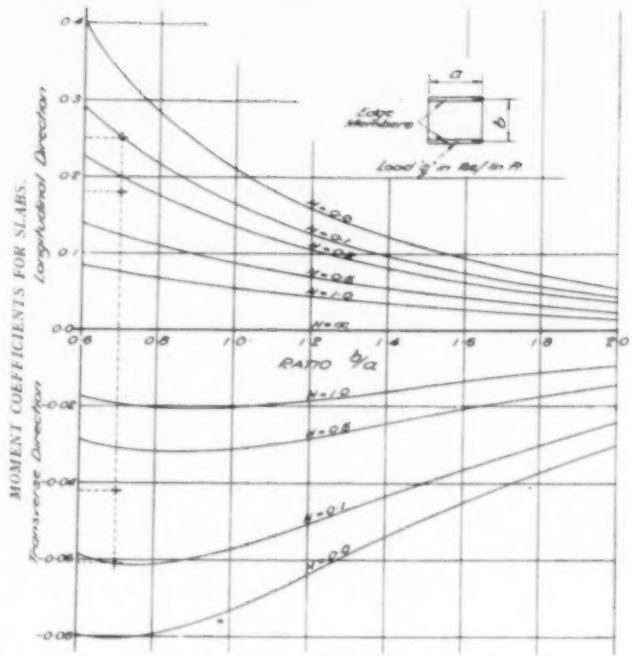
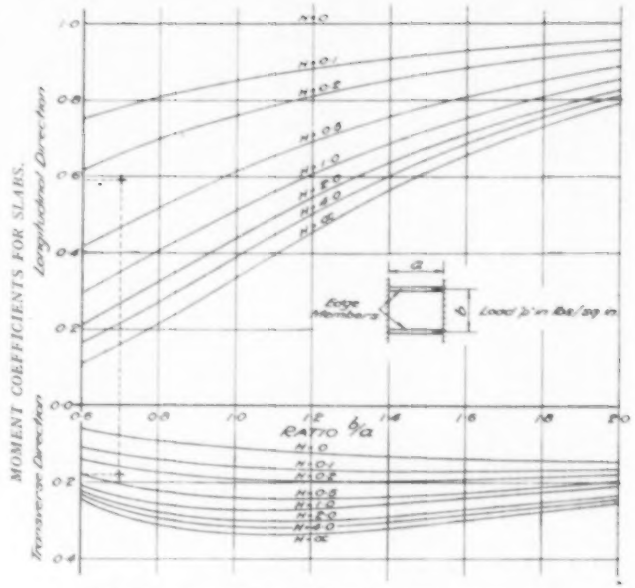


Fig. 3.—Support Conditions and suggested Slenderness Ratios for Prestressed Slab with Stiffened Edges.



Bending moments in longitudinal and transverse directions = coeff. $\times q \times a$. H = stiffness factor.

Fig. 4.—Bending Moments on Slab due to Line Loads Uniformly-distributed on Edge-Beams.



Bending moments in longitudinal and transverse directions = coeff. $\times \frac{pa^2}{8}$. H = stiffness factor.

Fig. 5.—Bending Moments on Slab due to Uniformly-distributed Load p.

two edges ($H = 0$) and on four edges ($H = \infty$). The condition for a slab supported on two edges with elastic edge-beams supporting the other two edges is indicated by the curves $H = 0{\cdot}5$.

Fig. 3 shows the conditions of support of the slab and gives the suggested slenderness ratios, which are between 1 : 35 for a slab supported on two edges ($H = 0$) and 1 : 50 for a slab supported on four edges ($H = \infty$).

The bending moments are calculated and the stresses are checked at the following stages. (1) When the slabs are in position and carry their own weight. (2) When lateral prestressing is effective between the road and the footpath slabs. (3) When the footpath slabs carry their own weight and the dead weight of the topping. (4) When the footpath slabs, the topping, and the road slabs work together as a composite structure; that is, when they carry the wearing surface and fence and the live loads (20-tons wheel load and footpath load).

Example.

The following example shows a method of applying Professor Jensen's curves for bending moments (*Figs.* 4 to 9) to composite prestressed concrete bridges. $a = 38{\cdot}5$ ft.; $b = 26{\cdot}5$ ft.; allowable $f_t = 1700$ lb. per square inch; $f_b = 2000$ lb. per square inch; $t = 140{,}000$ lb. per square inch. Assume an average thickness of slab of 13·5 in. (15 in. at the crown and 12 in. near the edge-beams), width of edge-beam b_1 of 30 in., and height of edge-beam h_1 of 15 in. Then, before composite action takes place between the footpath slabs and the topping,

$$H = \frac{b_1(1-\mu^2)}{a}\left(\frac{h_1}{h}\right)^3 = \frac{30 \times 0{\cdot}98}{38{\cdot}5 \times 12}\left(\frac{15}{13{\cdot}5}\right)^3 = 0{\cdot}1 \text{ approximately,}$$

and, after the composite structure is formed by the footpath slabs and the topping, with $b_1 = 27$ in. and $h_2 = 24$ in.,

$$H = \frac{b_1(1-\mu^2)}{a}\left(\frac{h_2}{h}\right)^3 = \frac{27 \times 0{\cdot}98}{38{\cdot}5 \times 12}\left(\frac{24}{13{\cdot}5}\right)^3 = 0{\cdot}3 \text{ approximately.}$$

The lower quality of the concrete in the topping has been taken into account by using a reduced width of $\frac{n_1}{n_2} \times b_1 = \frac{8}{10} \times 30 = 24$ in. instead of 30 in. for the topping and a corresponding average width of 27 in. for the entire composite section.

DEAD LOADS: Weight of slab at the centre of the road = 188 lb. per square foot.
Weight of wearing surface = 20 lb. per square foot.
Weight of slabs for edge-beam, $188 \times 2{\cdot}5 = 470$ lb. per foot.
Weight of topping on edge-beam, $0{\cdot}75 \times 2{\cdot}5 \times 150 = 280$ lb. per foot.
Weight of fence = 30 lb. per foot.

LIVE LOADS: Single 20-tons wheel load (including impact);
Footpath load = 100 lb. per linear foot.

BENDING MOMENTS AND STRESSES AT CENTRE OF SLAB IN LONGITUDINAL DIRECTION:

Due to weight of slab, $M = p \times a^2 \times \frac{1}{8} = 188 \times 38{\cdot}5^2 \times \frac{1}{8} = 34{,}800$ ft.-lb.

Due to topping on edge-beam. From the top of *Fig.* 4, for $\frac{b}{a} = 0{\cdot}7$ and $H = 0{\cdot}1$,

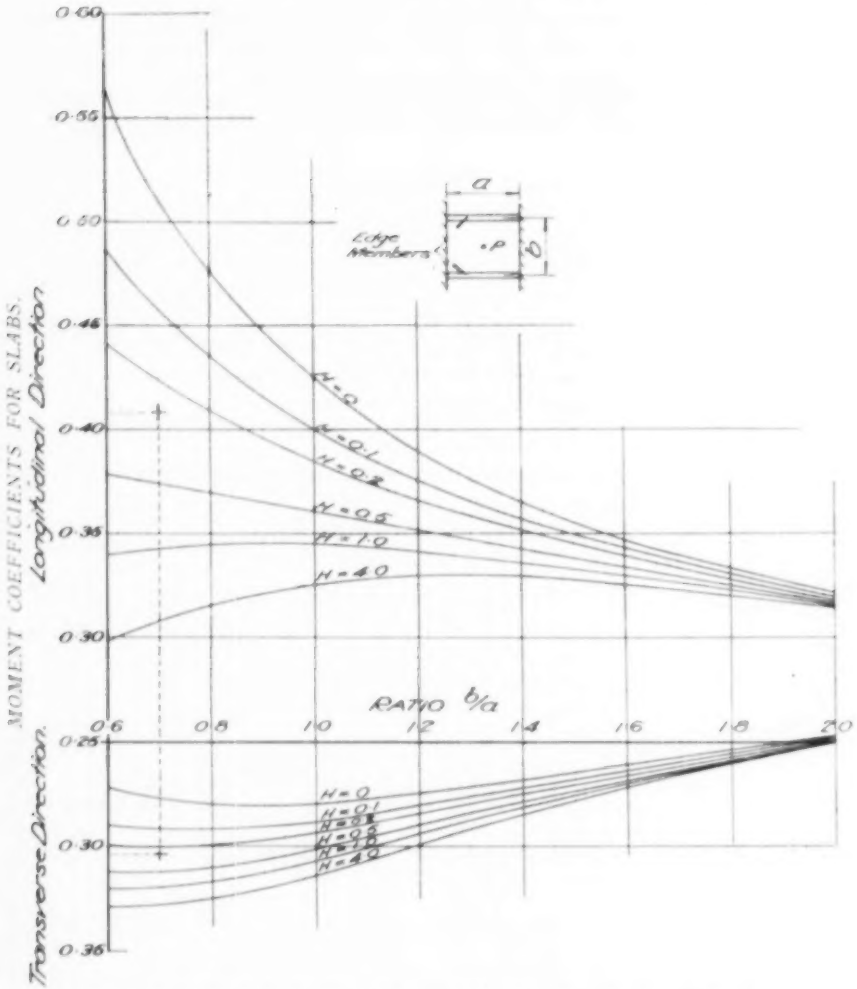
$$M = C \times q \times a = 0{\cdot}25 \times 280 \times 38{\cdot}5 = 2700 \text{ ft.-lb.}$$

Due to wearing surface. From the top of *Fig.* 5, for $\frac{b}{a} = 0{\cdot}7$ and $H = 0{\cdot}3$,

$$M = C \times p \times a^2 \times \tfrac{1}{8} = 0{\cdot}59 \times 20 \times 38{\cdot}5^2 \times \tfrac{1}{8} = 2190 \text{ ft.-lb.}$$

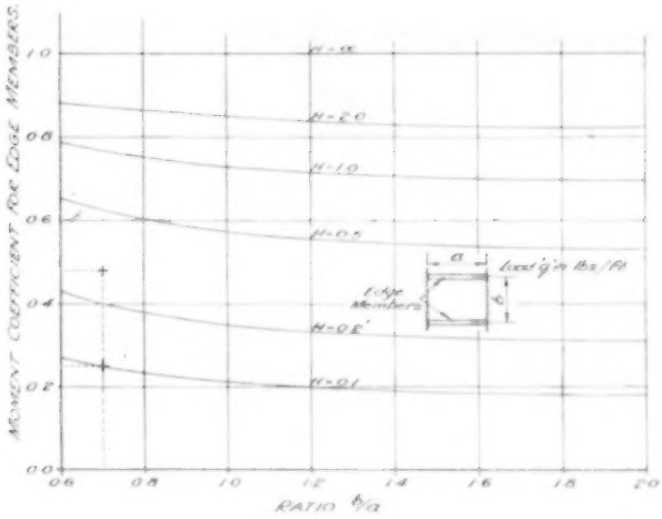
Due to fence. From top of *Fig.* 4 for $\frac{b}{a} = 0{\cdot}7$ and $H = 0{\cdot}3$,

$$M = C \times q \times a = 0{\cdot}18 \times 30 \times 38{\cdot}5 = 200 \text{ ft.-lb.}$$



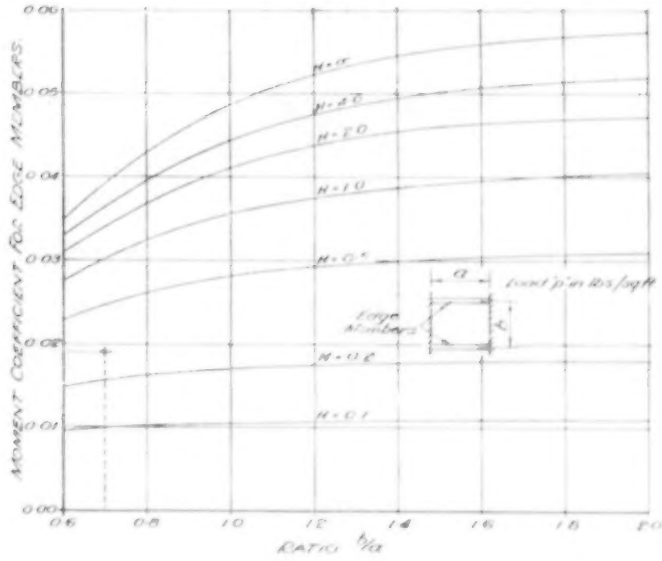
Bending moments in longitudinal and transverse directions = coeff. × P;
P = wheel load; H = stiffness factor.

Fig. 6.—Bending Moments on Deck Slab due to one Wheel Load P



Span moments = $\frac{\text{coeff.} \times q \times a^2}{8}$; H = stiffness factor.

Fig. 7.—Bending Moments on Edge Members due to Uniform Line Load on Edge Members.



Span moments = coeff. $\times p \times a^2$; H = stiffness factor.

Fig. 8.—Bending Moments on Edge Members due to Uniformly-distributed Load on Deck Slab.

Due to 20-tons wheel load. From the top of *Fig.* 6 for $\frac{b}{a} = 0{\cdot}7$ and $H = 0{\cdot}3$,

$$M = C \times P = 0{\cdot}408 \times 20 \times 2240 = 18{,}300 \text{ ft.-lb.}$$

Due to live load on footpath. From the top of *Fig.* 4 for $\frac{b}{a} = 0{\cdot}7$ and $H = 0{\cdot}3$,

$$M = C \times q \times a = 0{\cdot}18 \times 100 \times 38{\cdot}5 = 690 \text{ ft.-lb.}$$

Properties of section at centre of slab: $A = 12 \times 15 = 180$ sq. in. $I = 12 \times 15^3 \times \frac{1}{12} = 3375$ in.^{4}. $Z = 12 \times 15^2 \times \frac{1}{6} = 450$ in.^{3}.

Maximum stresses:

Due to weight of slab, $f = \frac{M}{Z} = \frac{34{,}800 \times 12}{450} = 930$ lb. per square inch.

Due to dead loads (edge-beam topping, wearing surface, and fence),

$$f = \frac{(2700 + 2190 + 200) \times 12}{450} = 136 \text{ lb. per square inch.}$$

Due to live loads (20-tons wheel load and live load on footpath),

$$f = \frac{(18{,}300 + 690) \times 12}{450} = 505 \text{ lb. per square inch.}$$

BENDING MOMENTS AND STRESSES IN CENTRE OF SLAB IN TRANSVERSE DIRECTION:

Due to topping on edge-beam. From the bottom of *Fig.* 4 for $\frac{b}{a} = 0{\cdot}7$ and $H = 0{\cdot}1$,

$$M = -C \times q \times a = -0{\cdot}605 \times 280 \times 38{\cdot}5 = -655 \text{ ft.-lb.}$$

Due to wearing surface. From the bottom of *Fig.* 5, for $\frac{b}{a} = 0{\cdot}7$ and $H = 0{\cdot}3$,

$$M = C \times p \times a^2 \times \tfrac{1}{8} = 0{\cdot}18 \times 20 \times 38{\cdot}5^2 \times \tfrac{1}{8} = 665 \text{ ft.-lb.}$$

Due to fence. From the bottom of *Fig.* 4, for $\frac{b}{a} = 0{\cdot}7$ and $H = 0{\cdot}3$,

$$M = -C \times q \times a = -0{\cdot}042 \times 30 \times 38{\cdot}5 = -50 \text{ ft.-lb.}$$

Due to 20-tons wheel load. From the bottom of *Fig.* 6, for $\frac{b}{a} = 0{\cdot}7$ and $H = 0{\cdot}3$,

$$M = C \times P = 0{\cdot}303 \times 20 \times 2240 = 13{,}550 \text{ ft.-lb.}$$

Properties of section: $A = 12 \times 15 = 180$ sq. in.
$I = 12 \times 15^3 \times \frac{1}{12} = 3375$ in.^{4}.
$Z = 12 \times 15^2 \times \frac{1}{6} = 450$ in.^{3}.

Maximum stresses: Due to topping on edge-beam, wearing surface, and fence,

$$f = \frac{(-655 + 665 - 50) \times 12}{450} = 0 \text{ (approx.).}$$

Due to 20-tons wheel load, $f = \frac{(13{,}550 \times 12)}{450} = 360$ lb. per square inch.

BENDING MOMENTS AND STRESSES IN EDGE-BEAM:

Due to edge-beam,

$$M = q \times a^2 \times \tfrac{1}{8} = 470 \times 38{\cdot}5^2 \times \tfrac{1}{8} = 86{,}900 \text{ ft.-lb.}$$

Due to topping on edge-beam. From *Fig.* 7, for $\frac{b}{a} = 0{\cdot}7$ and $H = 0{\cdot}1$,

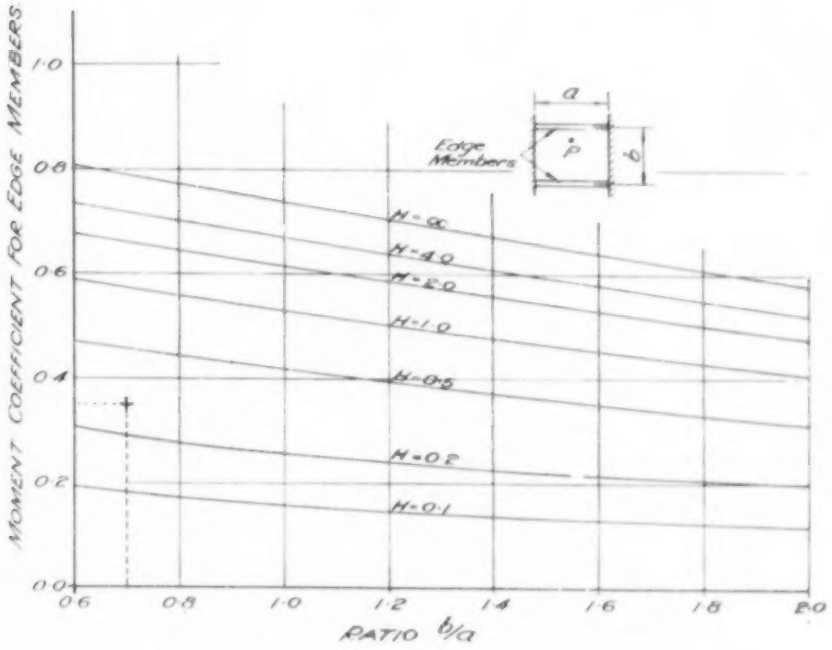
$$M = C \times q \times a^2 \times \tfrac{1}{8} = 0{\cdot}25 \times 280 \times 38{\cdot}5^2 \times \tfrac{1}{8} = 13{,}000 \text{ ft.-lb.}$$

Due to wearing surface. From *Fig.* 8 for $\frac{b}{a} = 0{\cdot}7$ and $H = 0{\cdot}3$,

$$M = C \times p \times a^3 = 0{\cdot}019 \times 20 \times 38{\cdot}5^3 = 21{,}700 \text{ ft.-lb.}$$

Due to fence. From *Fig.* 7, for $\frac{b}{a} = 0{\cdot}7$ and $H = 0{\cdot}3$,

$$M = C \times q \times a^2 \times \tfrac{1}{8} = 0{\cdot}48 \times 30 \times 38{\cdot}5^2 \times \tfrac{1}{8} = 2670 \text{ ft.-lb.}$$



Span moments $= \frac{\text{coeff.} \times P \times a}{4}$. H = stiffness factor.

Fig. 9.—Bending Moments on Edge Members due to One Wheel Load *P* on Slab.

Due to 20-tons wheel load. From *Fig.* 9, for $\frac{b}{a} = 0{\cdot}7$ and $H = 0{\cdot}3$,

$$M = C \times P \times a \times \tfrac{1}{4} = 0{\cdot}35 \times 20 \times 2240 \times 38{\cdot}5 \times \tfrac{1}{4} = 151{,}000 \text{ ft.-lb.}$$

Due to live load on footpath. From *Fig.* 7, for $\frac{b}{a} = 0{\cdot}7$ and $H = 0{\cdot}3$,

$$M = C \times q \times a^2 \times \tfrac{1}{8} = 0{\cdot}48 \times 100 \times 38{\cdot}5^2 \times \tfrac{1}{8} = 8900 \text{ ft.-lb.}$$

Properties of section; Before the topping has been added,

$A = 30 \times 15 = 450$ sq. in. $I = 30 \times 15^3 \times \frac{1}{12} = 8450$ in.^{4}.
$Z = 30 \times 15^2 \times \frac{1}{6} = 1125$ in.^{3}.

After the topping has been added,

$A = 27 \times 24 = 648$ sq. in. $I = 27 \times 24^3 \times \frac{1}{12} = 31{,}100$ in.^{4}.
$Z = 27 \times 24^2 \times \frac{1}{6} = 2590$ in.^{3}.

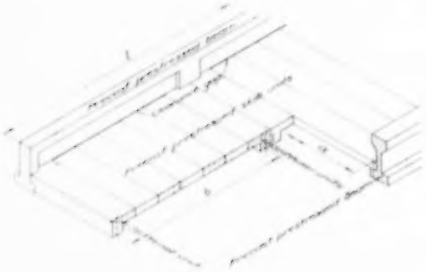


Fig. 10.

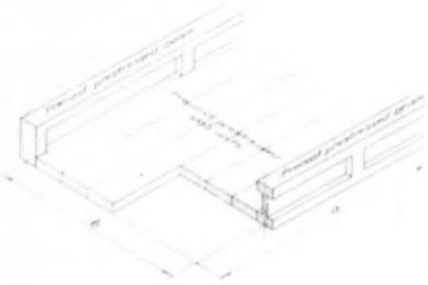


Fig. 11.

Maximum stresses: Due to weight of slab,

$$f = \frac{86{,}900 \times 12}{1125} = 925 \text{ lb. per square inch.}$$

Due to edge-beam topping, $f = \dfrac{13{,}000 \times 12}{1125} = 139$ lb. per square inch.

Due to wearing surface and fence,

$$f = \frac{(21{,}700 + 2670) \times 12}{2590} = 113 \text{ lb. per square inch.}$$

Due to 20-tons wheel load and live load on footpath,

$$f = \frac{(151{,}000 + 8900) \times 12}{2590} = 738 \text{ lb. per square inch.}$$

Having calculated the maximum longitudinal and transverse stresses in the slab and the stresses in the edge-beams, stress-distribution diagrams can be drawn and the assumed dimensions can be checked. The prestressing force and its eccentricity and the area of the cables can then be calculated in the usual manner. Secondary stresses caused by the shrinkage of the in-situ topping relative to the precast slabs are neglected in the example as they have little practical effect.

Fig. 11 shows a variation of the type of bridge described, and *Fig.* 10 shows a through-girder bridge. The latter consists of two large prestressed precast beams and several prestressed precast slabs. In order that the slabs should act together they are prestressed together at right angles to their length.

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Courses on Concrete.

The Cement and Concrete Association has added a new demonstration hall and structures laboratory to its research department at Wexham Springs, and these will be used for training courses for engineers and for supervisors to be held this year.

The course for engineers deals with properties of concrete, concrete mixtures, soil-cement, structural concrete, and concrete roads; the course will be held from May to September. The course for supervisors (from January to April) includes structural concrete, concrete roads, and soil-cement. In addition there will be advanced courses on structural concrete for senior engineers in November.

A new departure is a course on concrete products to be held in October for members and employees of firms subscribing to the Research Committee for the Cast Stone and Cast Concrete Products Industry. The main emphasis in this course will be on developments in the manufacture and use of precast concrete. The syllabus will deal with all aspects of the subject, and there will be a visit to a concrete products works where prestressed concrete products are being made.

There will also be discussion groups and lectures for those teaching at courses for the certificate on concrete practice of the City and Guilds of London Institute, to be held in July, when advice will be available on the best methods of instruction in courses of this kind. The experience gained in the Association's course for supervisors will be at the disposal of those attending.

The courses are of four or four-and-a-half days' duration, and hostel accommodation is available at the training centre. There is no charge for the courses or for attending the lectures and demonstrations, and the cost of hostel accommodation and meals is from £4 to £5 per course. Further details and forms of application may be obtained from the Association, 52 Grosvenor Gardens, London, S.W.1.

Pulverized-fuel Ash for Aden Harbour Works.

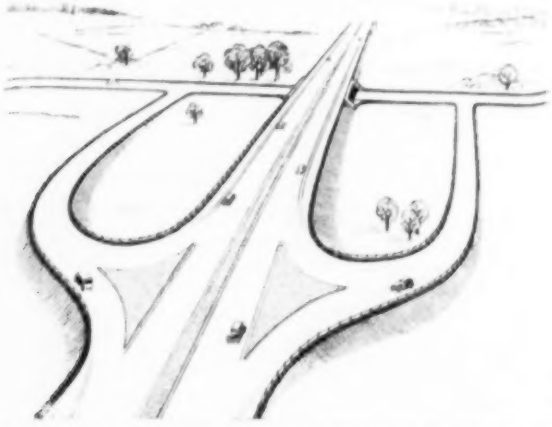
Pulverised-fuel ash is now being sent from the Littlebrook (Dartford) power station for use in the new harbour works at Aden. The initial contract is for 1450 tons, which is to be used as a partial replacement of cement in the concrete work. The contractors are Messrs. Pauling & Co., Ltd., and the consulting engineers are Sir Bruce White, Wolf Barry & Partners.

Proposed Subway under the Firth of Forth.

On page 129 is illustrated a proposal for a vehicular crossing of the Firth of Forth near the present railway bridge. The originator of the project is Mr. G. A. Maunsell, M.I.C.E. (who conceived the reinforced concrete floating forts installed in the Thames estuary during the war, and has been responsible for a number of floating docks in various parts of the world), and it has been developed by Messrs. Maunsell, Posford & Pavry and Sir Alexander Gibb & Partners.

The project has been submitted to the Secretary of State for Scotland for consideration, and is shown in *Figs.* 1 and 2. From each of the banks to the ventilation shafts (*Fig.* 1) the subway would be built in cast-in-place concrete within cofferdams, in shallow water, on rock. The middle section, about two-thirds of a mile long, would be built as in *Fig.* 2, which shows a cross section of the reinforced concrete subway and its supporting concrete piles and the profile of a ship with a draught of 36 ft. passing over it at low water. The subway would be 88 ft. wide by 27 ft. deep and provide two carriageways each 22 ft. wide. Ventilating ducts are provided at each side. The maximum depth of water is about 200 ft., and the subway would be carried on caisson piles of large diameter as used by the author of the project in the construction of a wharf in Gambia. The subway would be constructed in long sections cast in a dry dock on the bank of the river, and temporary bulkheads would be fitted at each end to enable the sections to be towed into position and sunk on to the piles. The sections would be joined by a form of pressure-compacted joint specially developed for this subway; this method would enable a natural hydraulic force of 3000 tons to be brought into service to effect a watertight seal between the sections.

It is estimated that the cost of this scheme would be about £5,500,000, compared with about £15,000,000 for a bridge, that it would require about 400,000 tons less steel than a bridge, and that the subway could be built in three years compared with eight years for a bridge. It is also anticipated that the annual cost of ventilating the subway and of any pumping that might be necessary would be less than the cost of maintenance of a steel bridge. Important considerations are that a subway would not obstruct the view of the present Forth bridge, and that its use would not be prevented by gales.



Proposed Junction of Motor Road and Existing Road. (*See p.* 115.)

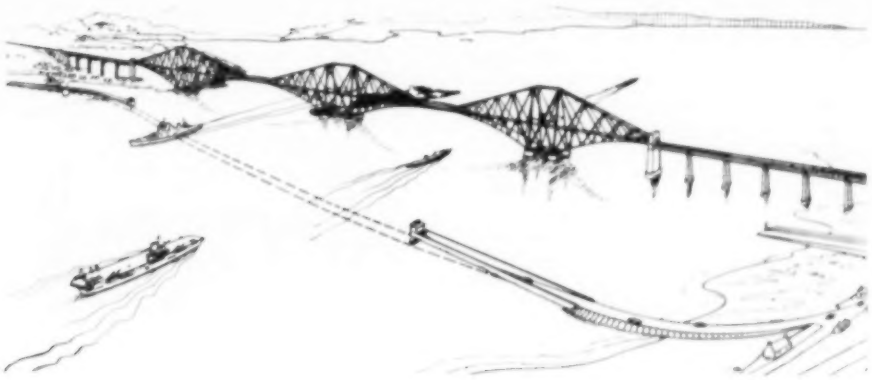


Fig. 1.

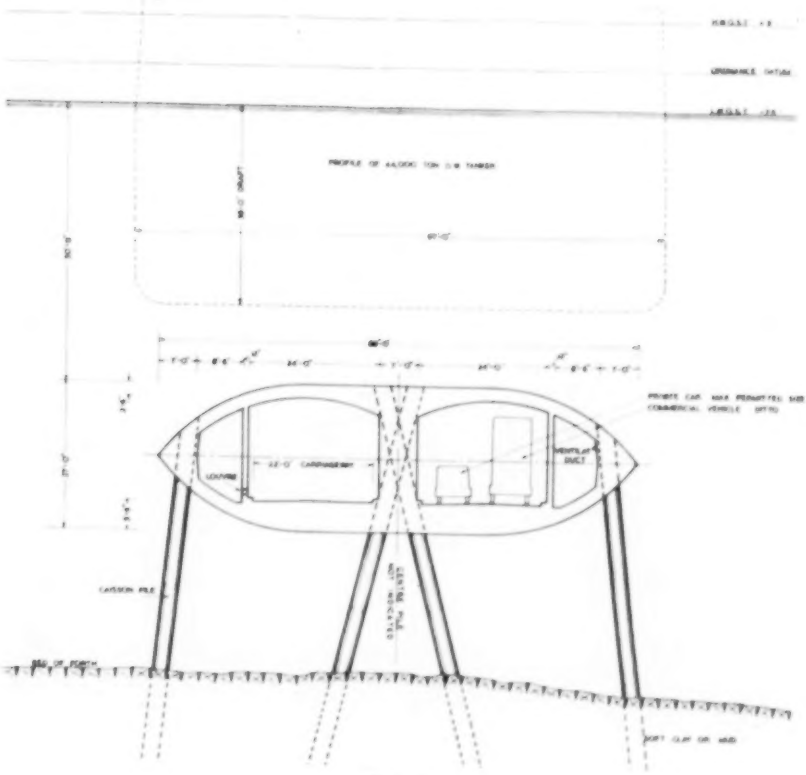


Fig. 2.

A Proposal for a Crossing of the Firth of Forth. (*See facing page.*)

New Method of Precast Construction.

MONOLITHIC FRAMES.

THE method of precast concrete construction described has been devised by Mr. Alexandre Major, of Budapest. It is more fully described in "Acta Technica," published by the Hungarian Academy of Sciences, by whose permission the following is published. The principal advantages claimed for the system are speed of construction, the absence of power lifting devices, and the advantages of monolithic frames.

One method is shown in *Fig.* 1. A scaffolding mounted on wheels and carrying the shuttering is used to cast alternate sections each of which comprises two or more frames and connecting beams. After concreting one of these sections the scaffolding is pulled by winches along the track and used for concreting the next section but one. Meanwhile reinforced concrete beams are cast on the ground for connecting the monolithic sections; these beams are placed in position by pulleys fixed on the ends of the frames (*Fig.* 3) and rest on the projecting ends of the beams of the frames; their position is determined by projecting steel bars. If the building has several bays, alternate sections of alternate bays (that is chessboard pattern) are constructed as described above, and the bays and sections connected by precast beams. *Fig.* 1 shows the construction of a single-bay building, one section having been cast and the scaffolding and shuttering moved for concreting the next section but one. This building is 750 ft.

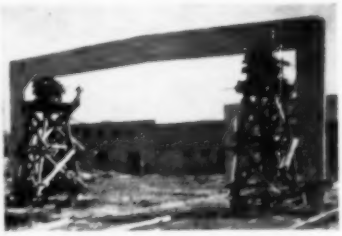


Fig. 2.—Transporting a Frame.

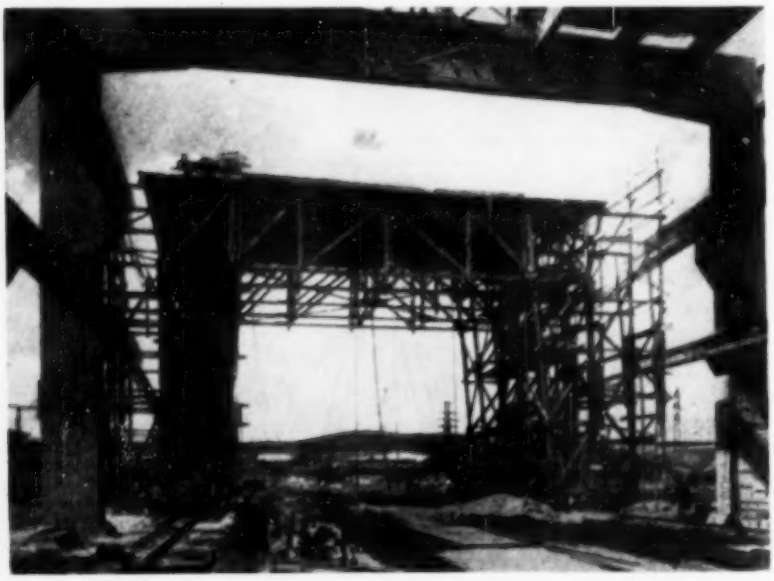


Fig. 1.—One Section cast and Shuttering moved for next Section.

long, and was built with two travelling scaffolds starting at the middle.

In a more recent method devised by Mr. Major reinforced concrete frames, arches, or other members are made vertically side by side within shuttering. *Fig.* 4 shows the principle of this system. The frames are cast together at one end of a track that traverses the site of the building, lifted by jacks on to towers, and transported along tracks to the required position (*Fig.* 2). The transport towers

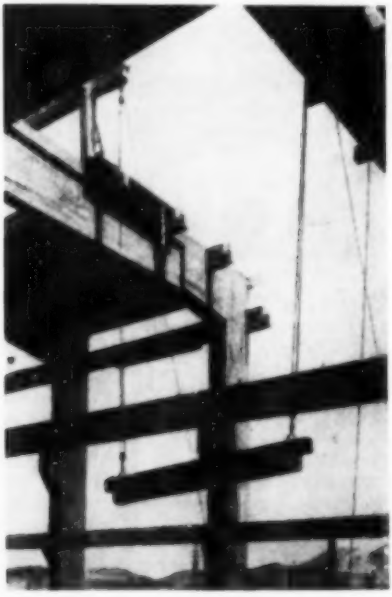


Fig. 3.—Erecting Beams to Connect Monolithic Sections Comprising Three Frames.

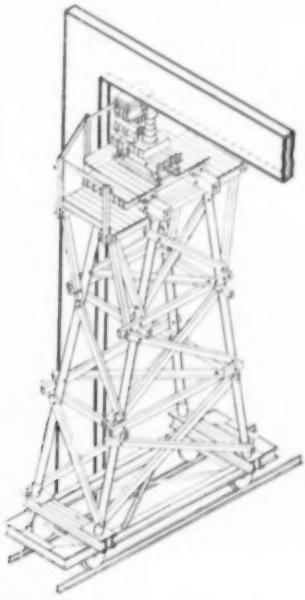


Fig. 5.—A Transport Tower.

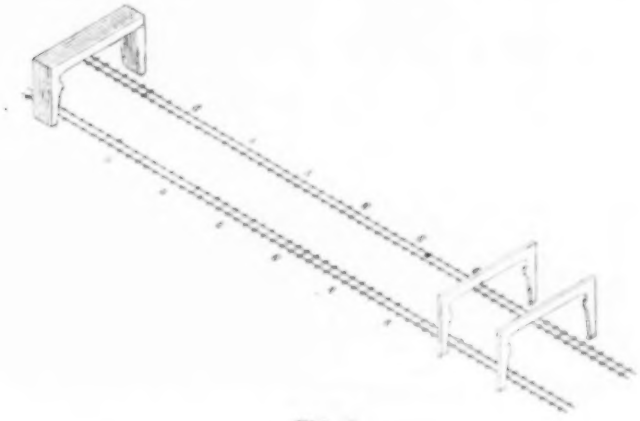


Fig. 4.

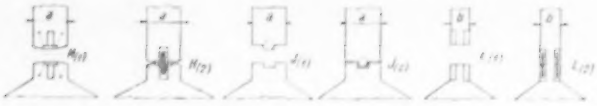


Fig. 6.—Connections of Frames to Footings.

(*Fig.* 5) consist of a steel chassis mounted on wheels, a timber tower, and at the top a jack that can be moved transversely on rails. The towers carrying a frame are moved by hand winches, and can carry frames weighing up to 80 tons.

The connections between the frames and the foundation are made as shown in *Fig.* 6. At H(1) and H(2) are shown a hinged joint, at J(1) and J(2) a hinged joint with welded steel plates, and at L(1) and L(2) a fixed joint with welded steel plates. When erected in position (*Fig.* 7) the frames are temporarily supported at the top and by timber struts. Transport by this means does not require additional steel reinforcement to resist stresses during handling.

An economical section for use in this system is shown in *Fig.* 8. The part of the shutter marked (1) can be re-used for concreting the next frame as shown at (2). To make the frames, only one shutter has to be erected in which ten to twelve frames can be cast. The frames are kept separate by a layer of plaster or other means of preventing adhesion.

Fig. 7.—Frames Temporarily supported at the Top.

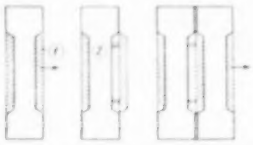


Fig. 8.—Recommended Shape.

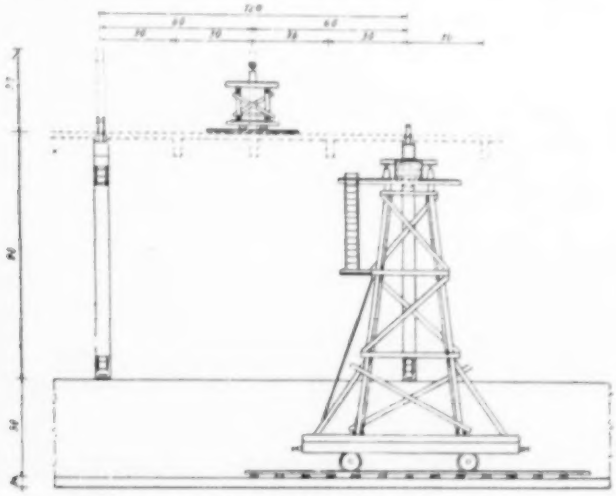


Fig. 9.—Erecting Multiple-story Structures.

Fig. 7 shows the construction of a pumping station. The frames rest on columns that are higher than the rails, and the transport tower is higher to allow for this. *Fig.* 9 shows the method of erecting frames above coal bins and indicates how the system is used in the construction of multiple-story buildings; the upper frames are erected above the lower frames by means of a truck.

While the frames are being cast, excavation and other preparatory work can be carried out on the site, and the whole site remains clear for the use of other trades and for the installation of machine foundations, etc.

Experience shows that from three to five frames can be erected each day, and that the complete reinforced concrete work of a single-story building 350 ft. long can be completed in from ten to twelve weeks. The cost of erecting these frames is stated to be from one-third to one-half of the cost of erecting frames cast horizontally, and that the overall saving in the cost of a structure is up to 12 per cent.

The system is also suitable for prestressed frames with post-tensioned steel.

A Prestressed Bridge in Amsterdam.

Concrete Elevator.

THE device shown in *Fig.* 1 was used to place the concrete for a large number of precast beams for the new Amstel bridge, Amsterdam. The beams were 100 ft. long, and were to be prestressed. The concrete was tipped from barrows into a container at ground level and taken up an elevator to the top of the shutters. The elevator was mounted on a track parallel to the shutters and moved along as required; it was not necessary to stop the elevator while it was being moved, so that concreting was not interrupted.

In order to release the steel moulds quickly the beams were cured in steam. This was done by erecting a double-walled tent over each beam and admitting steam at normal atmospheric pressure. After steam curing there was no difference in the strength of test cubes made with ordinary and rapid-hardening Portland cement. The time needed for the construction of each beam, including erection of shuttering, placing of cables, concreting, curing, and partly prestressing, was one week.

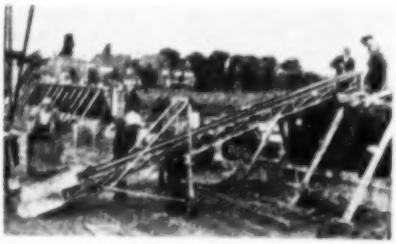


Fig. 1.

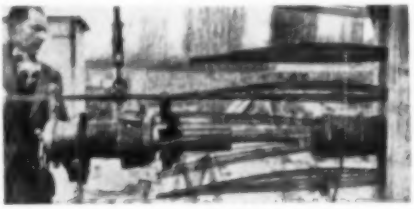


Fig. 2.

Measuring the Tensioning Force.

The force which the jack exerted on the concrete was measured directly; it is claimed that this is the first time that this has been done with the Freyssinet system. A hollow cylindrical pressure-box (*Fig.* 2) containing a variable resistance was placed between the jack and the anchor-cone. By means of an amplified Wheatstone bridge the force in the box could be read to an accuracy of 1 per cent. It was found that, within limits, the apparatus is suitable for use on the site. The apparatus was developed by Delft University and the Amsterdam Public Works Authority. The apparatus is not expensive, and the measurements did not delay the work.

The foregoing notes and illustrations are from "Cement" (Amsterdam) for August, 1954, in which this bridge is fully described.

Book Review.

"Design of Cylindrical Shell Roofs." By J. E. Gibson and D. W. Cooper. (London : E. & F. N. Spon, Ltd. 1954. Price £1 15s.)

THE design of shell roofs is regarded by some designers as being more of a feat of legerdemain than of ordinary calculation. No doubt this is because the calculations are involved and difficult and few attempts have been made to present them in a form which may be appreciated by engineers rather than by mathematicians. In this book the authors present the mathematical theory in a way which is easy to follow. The examples are related step by step to the calculations and it is thus possible to appreciate the significance of the mathematics. In general the method of calculating the stresses in a shell roof, making, of course, the usual assumptions of elasticity, is well done and well worth reading by all who wish to understand this form of construction. Particularly interesting are the comparisons between the simplified "beam-methods" for long shells and the analytical method, and the examples of the advantages of prestressing the edge-beams. The methods of calculating the reinforcement required, and the "typical" details showing the arrangement of the bars, are not so praiseworthy. In particular it is difficult to see how the method given on pages 103 and 104 can be substantiated in any way. There appears to be no justification for assuming a compressive stress in the concrete of 800 lb. per square inch, yet this assumed stress is used in an equation (given in an appendix) for determining the area of steel; the use of this equation could lead to ludicrous results in the hands of an inexperienced designer, for whom, apparently, the appendix is provided.

The reinforcement details could with advantage be redrawn for future editions, particularly *Fig.* 52 where the lowest bars require restraining at the re-entrant angle of the haunch, or detailing in another way. Also in future editions some minor inaccuracies should be corrected; there are, for example, two equations numbered (29), the values of n_1 and a_1 on page 101 are incorrect, and the name of a very well-known method of prestressing produced in this country is spelt incorrectly throughout. Notwithstanding these faults the book is the only one at the moment published in Great Britain that presents the theory of shell roofs in a fairly easy manner.—J. E. G.

Lectures on Building.

THE following lectures have been arranged by the Ministry of Works. Admission is free.

The Thermal Insulation of Buildings. By C. L. Haddon. Library, Corporation Street, Chesterfield. March 14. 7.15 p.m.

Productivity in House Building. By A. E. Chittenden. South-West Essex Technical College, Forest Road, London, E.17. March 10. 7.15 p.m.

Advantages of Thermal Insulation of Building Structures. By A. M. Palmer. Technical School, Whitehall, Chesham. March 15. 7 p.m. And Technical College, Market Road, Chelmsford. March 22. 7.30 p.m. By J. S. Alton. Technical College, Workington. March 17. 7 p.m.

Introduction to Prestressed Concrete. By R. C. Blyth. Gas Showrooms, Sandgate Road, Folkestone. March 17. 7 p.m.

Trends in the Development of Mechanical Plant for the Building Industry. By W. R. Matthews. Ministry of Works, Ashley Street, Birmingham. March 22. 7.15 p.m.

Dampness in Buildings. By A. G. Day. Technical College, Cauldon Place, Stoke-on-Trent. March 23. 7.15 p.m.

Design, Development and Production of a New Traditional House. By G. Grenfell Baines. Kirby Grammar School, Middlesbrough. March 24. 7 p.m.

Concrete Placing and Formwork. By A. B. Harman. Technical College, Erith Road, Belvedere, Kent. March 30. 7.15 p.m.

Closed Annular sections subjected to Bending and Direct Compression.—II.*

By J. RYGOL, B.Sc.(Eng.).

Use of Nomograms Nos. 2 and 3.

(a) Given t, R, N, M, and p, determine f_c and f_t. Decide a value of the modulus m and evaluate $e_N = \frac{M}{N}$ and $Q = \frac{M}{R^2t}$. From Nomogram No. 2 read the value of n and C $\left(mp \text{ and } \frac{e}{R} \text{ are known}\right)$. With C and Q known, find $\frac{f_t}{m}$ from Nomogram No. 3 $\left(\text{or calculate } \frac{f_t}{m} = \frac{Q}{C}\right)$. The value of U is read from the intersection diagram $\left[\text{or calculated from } U = \frac{1}{2 - n\left(n + \frac{t}{R}\right)}\right]$, and f_c is then determined by a straight-line alignment of $\frac{f_t}{m}$, U, and f_c $\left(\text{or calculate } f_c = U\frac{f_t}{m}\right)$.

EXAMPLE.—$t = 4$ in. $R = 30$ in. $N = 20$ tons. $M = 1800$ tons-in. $p = 3$ per cent. $m = 15$.

Solution.—$e_N = \frac{M}{N} = \frac{1800}{20} = 90$ in. $\frac{e_N}{R} = \frac{90}{30} = 3$. $mp = 15 \times 3 = 45$ per cent.

(1) $e = e_N$. $Q = \frac{M}{R^2t} = \frac{1800 \times 2240}{30^2 \times 4} = 1120$ lb. per square inch. From Nomogram No. 2, $n = 0{\cdot}80$ and $C = 4{\cdot}35$. Then $\frac{f_t}{m} = \frac{Q}{C} = \frac{1120}{4{\cdot}35} = 257$ lb. per square inch. Therefore $f_t = 15 \times 257 = 3860$ lb. per square inch and $f_c = 202$ lb. per square inch.

(2) $e = e_N + e_e$. From Nomogram No. 4 ($mp = 45$ per cent. and $n = 0{\cdot}80$), $\frac{e_e}{R} = 0{\cdot}35$. Therefore $\frac{e}{R} = \frac{e_N}{R} + \frac{e_e}{R} = 3 + 0{\cdot}35 = 3{\cdot}35$. From Nomogram No. 2 $\left(mp = 45 \text{ per cent. and } \frac{e}{R} = 3{\cdot}35\right)$, $n = 0{\cdot}79$ and $C = 4{\cdot}25$. No further correction of n is necessary.

$$\frac{f_t}{m} = \frac{Q}{C} = \frac{N(e_N + e_e)}{R^2tC} = \frac{20 \times 2240(90 + 10{\cdot}5)}{30^2 \times 4 \times 4{\cdot}25} = 295 \text{ lb. per square inch.}$$

Therefore $f_t = 15 \times 295 = 4410$ lb. per square inch and $f_c = 0{\cdot}762 \times 295 = 225$ lb. per square inch.

(b) Given N, M, f_c and f_t, design a suitable section. Decide the value m and evaluate $e_N = \frac{M}{N}$. Then either:

(i) *With values of t and R assumed or given, determine the reinforcement required.* From Nomogram No. 3, by straight-line alignment of lines $\frac{f_t}{m}$, Q, and C, find C

* *Concluded from February number.*

$\left(\text{or calculate } C = \frac{Q}{\frac{f_t}{m}}\right)$. From the same Nomogram determine the position of n_0 corresponding to the permissible stresses f_c and $\frac{f_t}{m}$ $\left(\text{or calculate } n_0 = \frac{2f_c - \frac{t}{R}\cdot\frac{f_t}{m}}{f_c + \frac{f_t}{m}}\right)$.

With C and $\frac{e}{R}$ known, find mp and the position of n from Nomogram No. 2. If n is less than n_0 the stress in the concrete is also less than is permissible and the design is satisfactory. If n is greater than n_0 the design must be based on the permissible stress in the concrete f_c. Now $C = \frac{Q}{f_c}\cdot\left(\frac{n + \frac{t}{R}}{2 - n}\right)$ [equation (10)]. Also C is a function of n and $\frac{e}{R}$, which is represented on Nomogram No. 2. Now assume a position of n (here n is greater than n_0). Evaluate C from equation (10) and check it against C obtained from Nomogram No. 2 (for a given ratio of $\frac{e}{R}$ and the assumed value of n). Tabulate C for different assumed positions of n and then determine by interpolation the true n and the corresponding modular percentage of reinforcement mp. Check the stresses f_t and f_c.

EXAMPLE.—M = 1,000,000 in.-lb. N = 100,000 lb. R = 12 in. t = 1·8 in. f_c = 800 lb. per square inch. f_t = 15,000 lb. per square inch. m = 15.

Solution.—$e_N = \frac{M}{N} = \frac{1{,}000{,}000}{100{,}000} = 10$ in. $\frac{t}{R} = \frac{1{\cdot}8}{12} = 0{\cdot}15$. $\frac{e_N}{R} = \frac{10}{12} = 0{\cdot}833$. $\frac{f_t}{m} = \frac{15{,}000}{15} = 1000$ lb. per square inch. $R^2t = 12^2 \times 1{\cdot}8 = 259$ in.^{3}.

$$n_0 = \frac{2f_c - \frac{t}{R}\cdot\frac{f_t}{m}}{f_c + \frac{f_t}{m}} = \frac{1600 - 150}{800 + 1000} = 0{\cdot}806.$$

(1) $e = e_N$. $Q = \frac{M}{R^2t} = \frac{1{,}000{,}000}{259} = 3860$ lb. per sq. in., $C = \frac{Q}{\frac{f_t}{m}} = \frac{3860}{1000} = 3{\cdot}86$.

From Nomogram No. 2 it is evident that n is greater than n_0 and therefore the design must be based on the permissible stress in the concrete.

$$C = \frac{Q}{f_c}\left(\frac{n + \frac{t}{R}}{2 - n}\right) = \frac{3860}{800}\left(\frac{n + 0{\cdot}15}{2 - n}\right) = 4{\cdot}82\left(\frac{n + 0{\cdot}15}{2 - n}\right).$$

C \ n	1·2	1·3	1·4
From Nomogram No. 2	5·90	8·2	12·50
From equation (10)	8·14	10·0	12·45

Thus $n = 1{\cdot}4$, and the reinforcement required is $mp = 45$ per cent. Therefore $p = 3$ per cent.

To check the stresses: $\frac{f_t}{m} = \frac{3860}{12{\cdot}5} = 309$ lb. per square inch. Therefore $f_t = 15 \times 309 = 4640$ lb. per square inch. $f_c = \frac{1{\cdot}4 + 0{\cdot}15}{2 - 1{\cdot}4} \times 309 = 798$ lb. per square inch.

(2) $e = e_N + e_e$. Assume that $n = 1{\cdot}4$ and $mp = 45$ per cent. as initial values. From Nomogram No. 4, $\frac{e_e}{R} = 0{\cdot}27$. Therefore $e_e = 0{\cdot}27 \times 12 = 3{\cdot}24$ in. and $\frac{e}{R} = \frac{10 + 3{\cdot}24}{12} = 1{\cdot}1$.

$$C = \frac{100{,}000 \times 13{\cdot}24}{259 \times 800}\left(\frac{n + 0{\cdot}15}{2 - n}\right) = 6{\cdot}38\left(\frac{n + 0{\cdot}15}{2 - n}\right) \text{ [equation (10)]}.$$

C		n = 1·1	1·2	1·25
$\frac{e}{R} = 1{\cdot}1$	from Nomogram No. 2	6·25	9·30	11·8
	from equation (10)	8·87	10·78	11·9

The mp corresponding to $n = 1{\cdot}25$ is 75 per cent. From Nomogram No. 4, $\frac{e_e}{R} = 0{\cdot}235$. Therefore $e_e = 0{\cdot}235 \times 12 = 2{\cdot}82$ in. and $\frac{e}{R} = \frac{10 + 2{\cdot}82}{12} = 1{\cdot}07$. Therefore

$$C = \frac{100{,}000 \times 12{\cdot}82}{259 \times 800}\left(\frac{n + 0{\cdot}15}{2 - n}\right) = 6{\cdot}19\left(\frac{n + 0{\cdot}15}{2 - n}\right) \text{ [equation (10)]}.$$

C		n = 1·2	1·25	1·27
$\frac{e}{R} = 1{\cdot}07$	from Nomogram No. 2	8·80	11·00	12·20
	from equation (10)	10·43	11·55	12·03

Therefore $n = 1{\cdot}27$, $mp = 75$ per cent., and $p = 5$ per cent.

To check the stresses: $\frac{f_t}{m} = \frac{100{,}000 \times 12{\cdot}82}{259 \times 12{\cdot}1} = 409$ lb. per square inch.

$f_t = 15 \times 409 = 6140$ lb. per square inch. $f_c = \frac{1{\cdot}27 + 0{\cdot}15}{2 - 1{\cdot}27} \times 409 = 797$ lb. per square inch.

(ii) *Assuming values of mp and* $\frac{t}{R}$, *determine the section.*—Evaluate the position of n_0 corresponding to the permissible stresses f_c and $\frac{f_t}{m}$ $\left(n_0 = \frac{2f_c - \frac{t}{R}.\frac{f_t}{m}}{f_c + \frac{f_t}{m}} \right)$. Assuming that the permissible tensile stress in the steel is reached first, determine $CR^3 = \frac{M}{\frac{t}{R}.\frac{f_t}{m}}$. Assume a position of n and, with the known value of mp, find from Nomogram No. 2 the values C and $\frac{e}{R}$. As e and CR^3 are known, evaluate the two values R. Tabulate the values R for different assumed positions of n (n less than n_0), and then determine by interpolation the true R. Check f_c and f_t.

If the design is to be based on the permissible stress in the concrete a similar procedure may be adopted.

EXAMPLE.—$M = 3700$ tons-in. $N = 65$ tons. $f_c = 600$ lb. per square inch. $f_t = 12{,}000$ lb. per sq. in. $m = 15$. Assume $mp = 20$ per cent. and $\frac{t}{R} = 0.15$.

Solution.—$e_N = \frac{M}{N} = \frac{3700}{65} = 57$ in. $\frac{f_t}{m} = \frac{12{,}000}{15} = 800$ lb. per square inch

$$n_0 = \frac{2f_c - \frac{t}{R}.\frac{f_t}{m}}{f_c + \frac{f_t}{m}} = \frac{1200 - 120}{600 + 800} = 0.772.$$

(1) $e = e_N$. $CR^3 = \frac{M}{\frac{t}{R}.\frac{f_t}{m}} = \frac{3700 \times 2240}{0.15 \times 800} = 69{,}100$ in.^{3}.

mp = 20 per cent.	n	0.77	0.72	0.70
	$\frac{e}{R}$	1.7	1.95	2.1
	R	33.5	29.3	27.1
	C	2.9	2.6	2.5
	R	29	29.8	30.2

Therefore $R = 29.5$ (say 30 in.). Then $t = 0.15 \times 30 = 4.5$ in. To check the stresses :

$$Q = \frac{M}{R^2 t} = \frac{3700 \times 2240}{30^2 \times 4.5} = 2050 \text{ lb. per square inch.}$$

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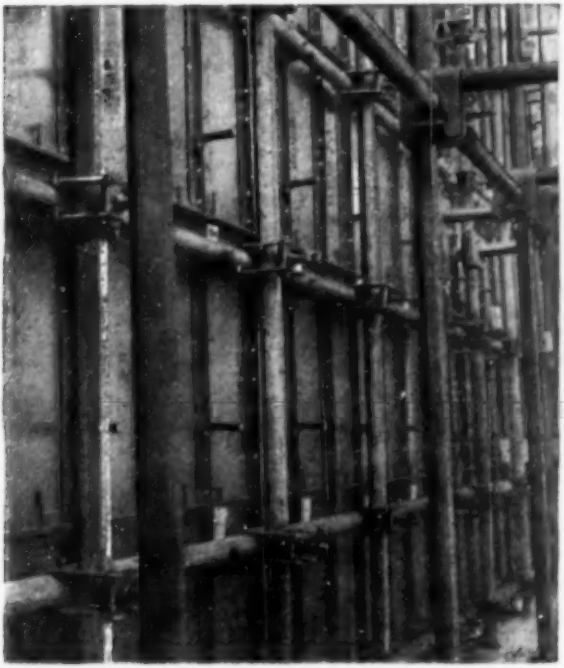

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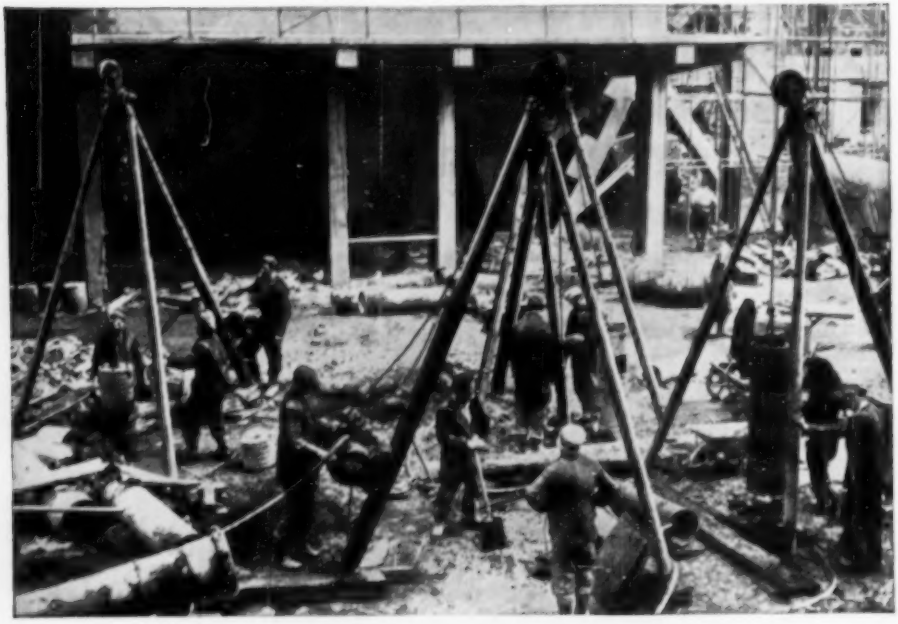

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$\frac{f_t}{m} = \frac{2050}{2{\cdot}6} = 789$ lb. per square inch; $f_t = 15 \times 789 = 11{,}890$ lb. per square inch; $f_c = \frac{0{\cdot}72 + 0{\cdot}15}{2 - 0{\cdot}72} \times 789 = 532$.

(2) $e = e_N + e_c$.

$$CR^3 = \frac{N(e_N + e_c)}{\frac{t}{R} \times \frac{f_t}{m}} = \frac{65 \times 2240}{0{\cdot}15 \times 800}(e_N + e_c) = 1213(e_N + e_c) = 1213(57 + e_c) \text{ in.}^3.$$

From Nomogram No. 4 ($n = 0{\cdot}72$, $mp = 20$ per cent.), $\frac{e_c}{R} = 0{\cdot}5$. Assuming $R = 30$ in., $e_c = 0{\cdot}5 \times 30 = 15$. Therefore $e = 57 + 15 = 72$ in. and

$$CR^3 = 1213 \times 72 = 87{,}300.$$

From Nomogram No. 2 $\left(\frac{e}{R} = \frac{72}{30} = 2{\cdot}4,\ mp = 20 \text{ per cent.}\right)$, $C = 2{\cdot}35$. $n = 0{\cdot}67$.

Therefore $R = \sqrt[3]{\frac{87{,}300}{2{\cdot}35}} = 33{\cdot}3$.

From Nomogram No. 4 ($n = 0{\cdot}67$, $mp = 20$ per cent.), $\frac{e_c}{R} = 0{\cdot}503$. Therefore, $e = 33{\cdot}3 \times 0{\cdot}503 = 16{\cdot}75$ in. and $\frac{e}{R} = \frac{57 + 16{\cdot}75}{33{\cdot}3} = 2{\cdot}21$.

From Nomogram No. 2 $\left(\frac{e}{R} = 2{\cdot}2,\ mp = 20 \text{ per cent.}\right)$, $C = 2{\cdot}45$. $n = 0{\cdot}69$. Therefore

$CR^3 = 1213(57 + 16{\cdot}75) = 89{,}500$ and $R = \sqrt[3]{\frac{89{,}500}{2{\cdot}45}} = 33{\cdot}2$ in. No further iteration is necessary. $R = 33{\cdot}2$ in. (say 33·5 in.). $t = 0{\cdot}15 \times 33{\cdot}2 = 5$ in.

To check the stresses: $R^2t = 33{\cdot}5^2 \times 5 = 5610$ in.^{3}.

$$Q = \frac{65 \times 2240(57 + 16{\cdot}75)}{5610} = 1915 \text{ lb. per square inch.}$$

$\frac{f_t}{m} = \frac{Q}{C} = \frac{1915}{2{\cdot}45} = 782$ lb. per square inch. Therefore $f_t = 15 \times 782 = 11{,}730$ lb. per square inch, and $f_c = \frac{0{\cdot}69 + 0{\cdot}15}{2 - 0{\cdot}69} \times 782 = 502$ lb. per square inch.

(c) Given all the properties of the section and permissible stresses, determine the maximum bending moment. From Nomogram No. 2, find C and n (mp is known and $\frac{e}{R} = \infty$). Assuming that the permissible stress in the steel is attained first, determine Q by straight-line alignment of lines C, $\frac{f_t}{m}$, and Q. From $Q = \frac{M}{R^2t}$, find M.

Check the stress in the concrete; if it is greater than is permissible, then the maximum resistance to bending moment will not be reached until the concrete attains sufficient strength. In this case both n and C are the same as before, but $\frac{f_t}{m}$ is now unknown. Obtain $\frac{f_t}{m}$ by straight-line alignment of lines f_c, U, and $\frac{f}{m}$. Then, as before, find Q and calculate M.

Example. Given $t = 4$ in., $R = 24$ in., $p = 2{\cdot}4$ per cent., $m = 15$, permissible stresses $f_c = 600$ lb.-in.^{2}, and $f_t = 12{,}000$ lb.-in.^{2} Find the maximum bending moment M.

Solution. $mp = 15 \times 2{\cdot}4 = 36$ per cent. $R^2t = 2304$ in.^{3}. From Nomogram No. 2, $n = 0{\cdot}6$ and $C = 2{\cdot}8$. With $\frac{f_t}{m} = \frac{12{,}000}{15} = 800$ lb.-in.^{2}, Q is 2240 lb.-in.^{2}. Therefore maximum bending moment $M = QR^2t = 2240 \times 2304 = 5{,}160{,}000$ lb.-in. and the stress in the concrete is 438 lb. per square inch $<$ 600 lb. per square inch.

Unusual Method of Welding Large Bars.

DURING the construction of the foundations of the Tappan Zee bridge across the Hudson river in the U.S.A. it was necessary to butt-weld 1¼-in. round bars and 2-in. square bars in the shuttering. The method used, which avoided the cost of bringing electrical power and equipment to the shutters, was described in "Engineering News-Record."

The bars were arranged with a gap of about ½ in. between the ends, and a mould of baked foundry-sand, in halves, was clamped together with the lower part of the mould fitting around the ends of the bars (*Fig.* 1). A short length of pipe was placed in the top of the mould, all the joints were sealed, and a welding compound was poured into the pipe and mould. The amount of compound used was 5 lb. for the 1¼-in. bars and 8 lb. for the 2-in bars. A thin steel disc was then placed on top of the welding compound and thermite put on top. The thermite was ignited by an oxyacetylene torch (*Fig.* 2), the thin steel disc preventing the burning thermite from flowing downwards until the temperature was sufficient to melt the disc and was high enough to ensure a good weld by melting the ends of the bars and allowing the molten metal to flow freely. Vertical holes in the mould (*Fig.* 3) allowed gases to escape. After cooling, the mould was removed and the slag around the weld was then chipped away with a hammer.

The bridge was designed by Mr. Emil H. Praeger (of Messrs. Madigan-Hyland) and the general contractors for the foundations are Messrs. Merritt-Chapman & Scott. The sub-contractors for the reinforced concrete work which included the welding, known as the Thermit process, were the Corbetta Construction Co., Inc.

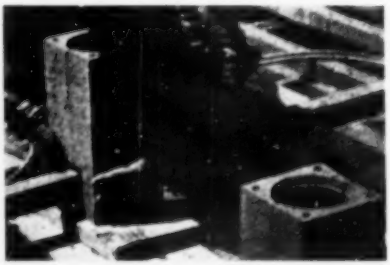

Fig. 1.—Placing the Moulds.

Fig. 2.—Igniting the Thermite.

Fig. 3.—Weld ready for Cleaning.

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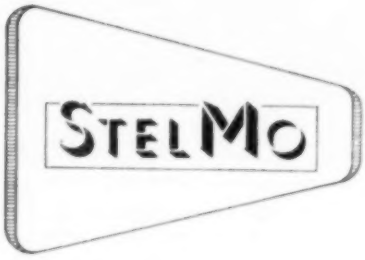

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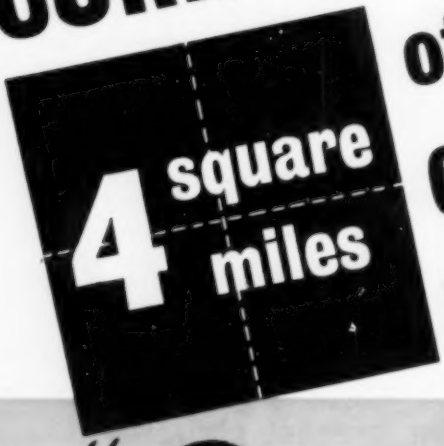

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Flat Slabs Supported by Columns without Capitals.

LIMITATIONS of the clear distance between floors has necessitated the use, during the reconstruction of a building at Mulhouse, France, of reinforced concrete slabs supported by columns only, without the use of beams or of capitals to the columns as is usual with flat-slab floors. The work is described by M. W. Thoma in the French journal "Travaux" for November, 1954.

The building originally consisted of wooden floors supported by wooden beams and columns, timber trusses carrying a tiled roof, and thick masonry walls. The existing roof and walls have been retained but the floors have been replaced by concrete slabs 6½ in. thick (*Fig.* 1). Transversely the slabs are supported at their outer edges by the walls and internally by two rows of columns, which divide the slabs into spans of 12 ft. 5 in., 13 ft. 1 in., and 12 ft. 5 in. Longitudinally there are eleven spans of 11 ft. 6 in.

On top of each slab is a layer of vermiculite concrete, about 2 in. thick, for heat and sound insulation. Electric conduits are placed in this insulating concrete and carried vertically through holes formed in the slab to the lighting points in the ceiling. Heating pipes were laid on top of the reinforcement in the lower part of the slab; this was done to provide greater security against cracking due to changes of temperature than is provided when the pipes are placed under the reinforcement, and it is considered that the difference in thermal efficiency is negligible.

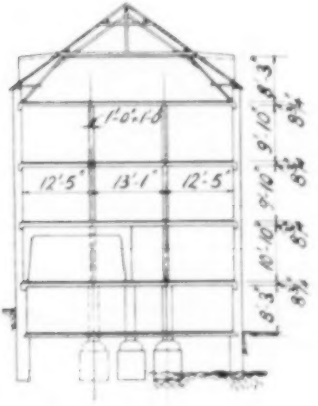

Fig. 1.—Cross Section.

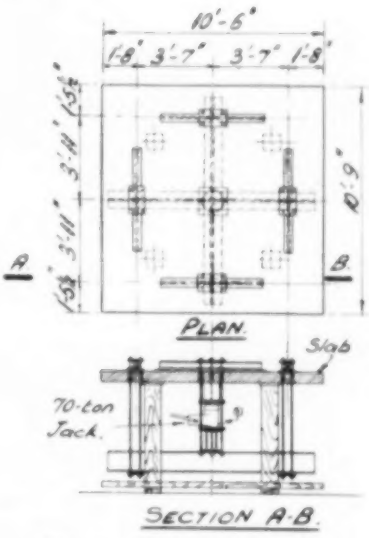

Fig. 2.—Method of Testing.

The imposed loads for which the floors are designed are from 100 lb. to 50 lb. per square foot. The permissible stresses are: Compressive stress in concrete due to bending, 1200 lb. per square inch; shearing stress in concrete, 60 lb. per square inch; tensile stress in steel, 20,400 lb. per square inch. Three methods of calculating the bending moments on a slab were used, namely that due to M. Sonier, that due to M. L'Hermite,* and the method described in the regulations of the American Concrete Institute. The coefficients for the bending moments used in the design are: Negative moment on a column strip, $\frac{1}{11 \cdot 5}$; positive moment on a column strip, $\frac{1}{23}$; negative moment on

* "Annales de l'Institut Technique du Bâtiment et des Travaux Publics," Juin, 1951. "Notes à propos de la théorie des plaques fléchies et des planchers-champignons."

a middle strip, $\frac{I}{31}$; positive moment on a middle strip, $\frac{I}{38}$. The coefficients refer to the bending moments on strips equal in width to half that of a slab and are due to the total load on a slab. The maximum shearing stress in a slab, around the top of a column, is 50 lb. per square inch. Although the shearing stress is less than that permissible it was considered advisable to place in the slabs bars bent upwards at 45 deg. towards the tops of the columns.

Tests of a Slab.

A slab 10 ft. 6 in. by 10 ft. 9 in. by 6¼ in. thick was tested to destruction in the manner shown in *Fig.* 2, the centrally placed 70-tons jack thrusting against the slab which was held along its edges by steel joists fixed to two other steel joists below the jack and thus providing a reaction to the thrust. Failure of the slab took place as indicated in *Fig.* 3 which shows the value of the bent-up bars in resisting shearing forces near a concentrated load. The upward deformation of the central part of the slab is shown in *Fig.* 4 in relation to the load exerted by the jack. It is seen that there is a factor of safety of 2 against cracking and of 5 against failure. After the building was completed many of the slabs were loaded, and under the imposed load for which they were designed the maximum deflection at the centre of a slab in an outer row was 0·04 in.

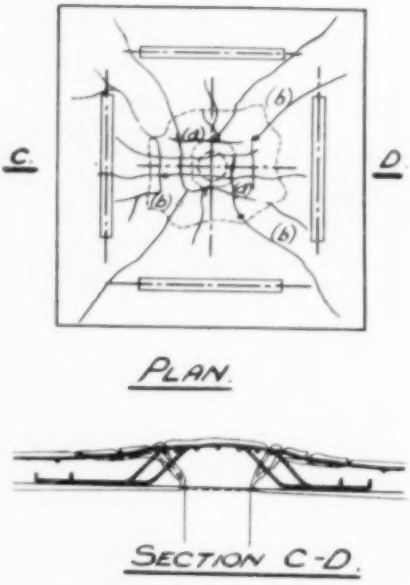

Fig. 3.—Plan and Section of Slab after Test.

[(a) Cracks at load of 25 tonnes. (b) Cracks at loads between 28 and 60 tonnes. The area enclosed by dotted lines was completely destroyed.]

The architect is M. Rene Rotter and the contractors Entreprise Zublin et Perriere, who also designed the reinforced concrete.

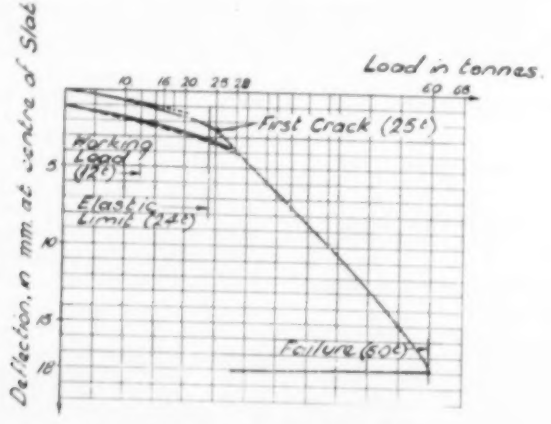

Fig. 4.—Deformation during Test.

Some views of the open-air swimming pool at the Skegness Holiday Camp. By kind permission of Messrs. Butlins Ltd.

★ waterproofing concrete with Sternson No. 300

Practical experience on a large number of water-containing structures has proved that STERNSON NO. 300 provides the most dependable means of obtaining a dense and impermeable concrete which will resist heavy water pressures. The list of important contracts on which STERNSON NO. 300 has been specified includes Swimming Pools, Factories, Harbour work, and underground structures of all types, and cement renderings on housing estates, etc. STERNSON NO. 300 is an integral waterproofer which can be used with confidence for all forms of concrete construction, and for providing a waterproof rendering for existing concrete and brick surfaces. STERNSON NO. 300 is a water repellent. It increases the tensile and crushing strengths without retarding the setting action. It increases the workability of the mix, thus permitting lower water-cement ratios. Full technical information on STERNSON NO. 300, and expert advice on all concrete waterproofing problems, are available on request.

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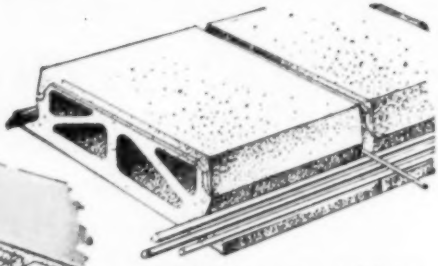
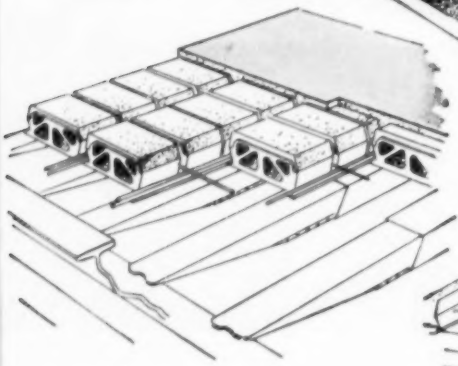
SMITH'S
FIREPROOF FLOORS

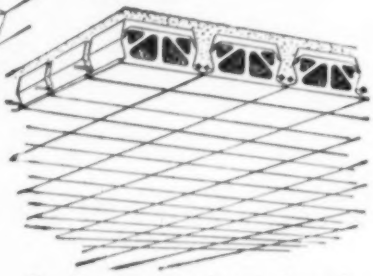
The most adaptable System of Suspended Hollow Concrete Floor and Roof Construction for large and small spans.



Showing Two-way Reinforcement and Hollow Concrete Blocks laid on Trianco Telescopic Centers.



Showing uniform concrete soffit. Obtained without use of slip tiles.



The Two-way Reinforced Floor for distribution of point loads with efficiency and economy, employing the original system of steel Telescopic Centers.

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IMBER COURT · EAST MOLESEY · SURREY
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Deformed Prestressing Bars.

A DEFORMED high-tensile steel bar for prestressed concrete is now supplied by McCalls Macalloy, Ltd. There are two longitudinal ribs and transverse ribs complying with the requirements of standard No. A305–50T of the American Society for Testing Materials. The guaranteed minimum 0·2 per cent. proof stress is 58 tons per square inch, and the ultimate strength about 70 tons per square inch. The maximum length of bars is 60 ft., and couplings are supplied for joining bars if longer lengths are required. The bars are available in three diameters with the same effective cross-sectional areas as round bars of $\frac{1}{2}$ in., $\frac{5}{8}$ in., and $\frac{3}{4}$ in. diameter, and the ends may be threaded for the attachment of temporary end fixing devices and for tensioning the bars.

In the case of prestressed members up to 25 ft. long the use of deformed bars makes possible a substantial reduction in the cost of the end fixings, as they are recovered for re-use. Instead of having threads on both ends of a bar, wedges may be used at one end as shown in *Fig. 1*. At the ends of a member wire helices are used as shown in *Fig. 2* to transfer the prestress to the concrete in a short length.

The Lee-McCall system of prestressed concrete construction has been selected for the new Kallang Basin bridge at Singapore. This bridge consists of twenty-five spans of 80 ft. each and a width of 65 ft. It will require some 500 tons of steel, delivery of which will commence shortly from Sheffield. This system is also being used by the Hindustan Construction Co., of Bombay, in the new Mahi bridge, near Baroda, in which there are sixteen spans of 110 ft., and for the new Gandy bridge to be built on the upper reach of Tampa Bay a few miles from the lower Tampa Bay bridge (recently completed) where there will be a total length of prestressed concrete construction of a little over 2½ miles, consisting of 252 spans of 48 ft. and twenty spans of 72 ft. The design for this bridge was prepared by the Florida State Highway Department Bridge Engineer (Mr. W. E. Dean) and the high-tensile steel prestressing bars will be supplied by the Stressteel Corporation, licensees of McCalls Macalloy, Ltd., in North America.

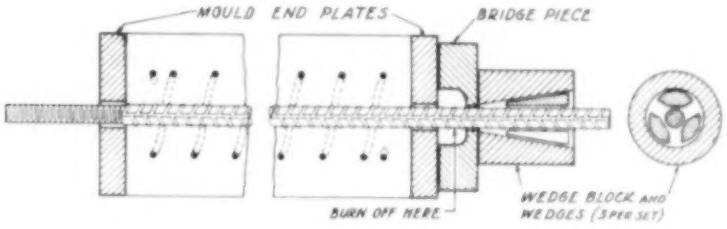


Fig. 1.

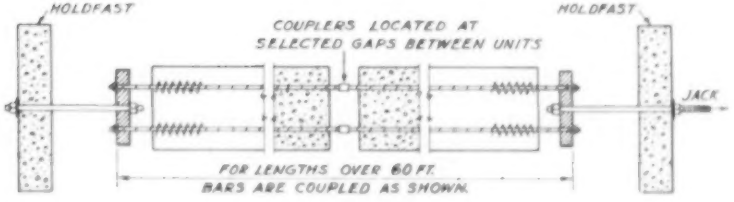
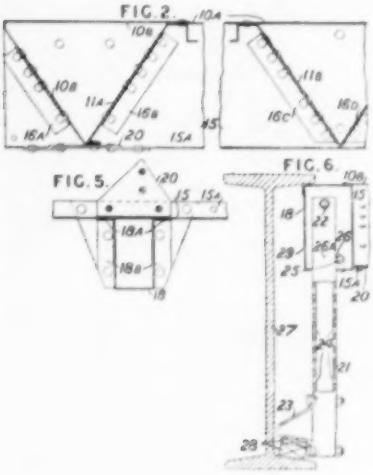

HOLDFAST
COUPLERS LOCATED AT SELECTED GAPS BETWEEN UNITS
HOLDFAST
JACK
FOR LENGTHS OVER 60 FT. BARS ARE COUPLED AS SHOWN

Fig. 2.

Patents Relating to Concrete.

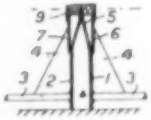
Shuttering for Floors and Walls.



A SHUTTERING element for casting walls or floors supported by parallel beams or columns, each of which has a longitudinal web perpendicular to the plane of the wall or floor and an outwardly-directed flange or flanges at each longitudinal edge of the web (for example, the member 27, *Fig.* 6), consists of a rectangular panel provided at its edges with at least one strut, at least one of which for example (21) is pivoted about an axis parallel to the length of the supporting member, the struts having abutment faces at an adjustable distance from the panel for acting against the lower or outer flanges of the beams or columns whilst holding the panel against the upper or inner flanges, the pivoted strut being held in operative position by positive locking means. As shown, the strut (21), hinged at (22), has a shoe (23) adjustably attached to the strut by bolts passing through any one of several pairs of holes (24). Wedges (28) are driven beneath the shoe. The strut is prevented from moving from a vertical or an oblique position by a locking-pin (25) passing through either of holes (26) or (26^A).

The panel consists of a main sheet of metal (10^A, *Fig.* 2) riveted to bent sheets (10^B, 11^A, 11^B, etc.), forming V-section longitudinal reinforcing channels running from edge to edge. The reinforcing channels are riveted by means of angle-members (16^A, 16^B, 16^C, 16^D, etc.) to L-shaped pressings (15, *Figs.* 2 and 6) at the edges of the panel. The edge members (15) have flanges (15^A) which are joined to the apices of the V-section channels by riveted triangular plates (20), *Fig.* 5. Fixed at intervals to members (15) for the reception of struts (21), are boxes (18), *Figs.* 5 and 6, formed of channel-shaped pressings, having flanges (18^A, 18^B) by which they are riveted in position. Slidable or removable extension plates may be attached to the edge members (15) to accommodate variations in span between beams or columns. To strike the shuttering, wedges (28) and locking-pin (25) are removed.—No. 626,506. Sir M. McAlpine and H. F. Rosevear, January 1947.

Joints in Roads.



A JOINT between adjacent concrete road slabs consist of two substantially parallel plates (1, 2) spaced apart so as to constitute shuttering and have elements on the outside for anchoring them in the slabs. The upper portions of the plates are inwardly and upwardly inclined and are rigidly united along the upper edges so as to form a roof-shaped portion which is resistant to deformation by vertical forces but susceptible of deformation by horizontal forces acting at right-angles. The plates (1, 2) are of the same length as the joint, and the upper edges (5) may be welded together. The upper edges are enclosed by upstanding plates (6, 7) welded on to the plates (1, 2) and are supported by struts (4) in the form of metal angle-plates serving also to support the anchor rods (3) welded on to the plates. In order to prevent concrete from entering the space between the plates (6, 7) during casting of the slabs, a cap (9) is temporarily placed on these plates. The space bounded by the sides of the slabs

This way forward

We've tamed Egyptian rivers,
Made ports for Portuguese,
Raised Herculean sea-walls,
To halt the seven seas;

Established firm foundations
Where once were shifting sands,
Set townships in the desert
And watered barren lands;

Built houses for your shelter
And stations for your trains
And silos for your harvest
And airports for your planes;

And yet the proudest story
We feel we have to tell
Is not "All this accomplished"
But "This accomplished *well!*"

SIR LINDSAY PARKINSON
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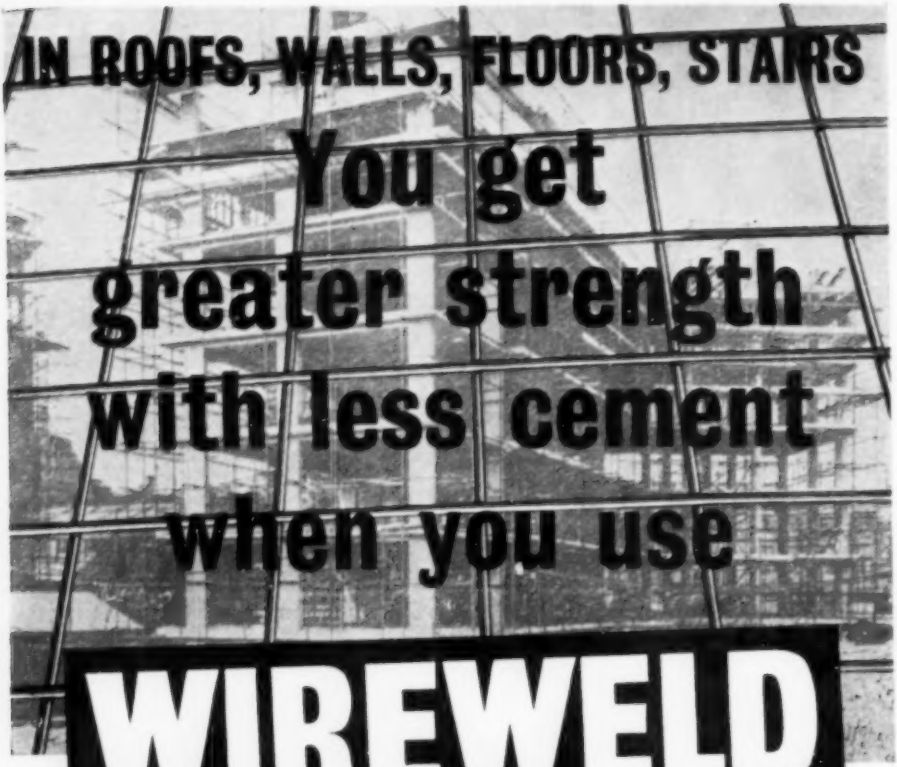
Interesting details of our 75 years experience gladly given to principals and consultants on request.



REINFORCEMENT

WIREWELD SAVES CEMENT!

The use of WIREWELD reinforcement obviates the need for extremely thick slabs of concrete. Reinforced concrete slabs only 3 in. thick have stood up satisfactorily for 5 years to heavy road traffic, but no *unreinforced* slabs less than 7 in. thick proved satisfactory.

WIREWELD SAVES MONEY!

WIREWELD reinforcement, easy to handle and quick to lay, makes possible considerable economies in road construction costs, and because of the long life of concrete roads reinforced with WIREWELD, maintenance costs are reduced to the minimum.

WIREWELD FOR STRENGTH!

WIREWELD reinforcement is a high tensile steel fabric, manufactured from Cold Drawn steel wire, electrically welded at all intersections, to B S 1221, Part A. Made in square mesh and oblong mesh, it gives maximum strength with the minimum of metal.

A PRODUCT OF TWISTEEL REINFORCEMENT LTD.

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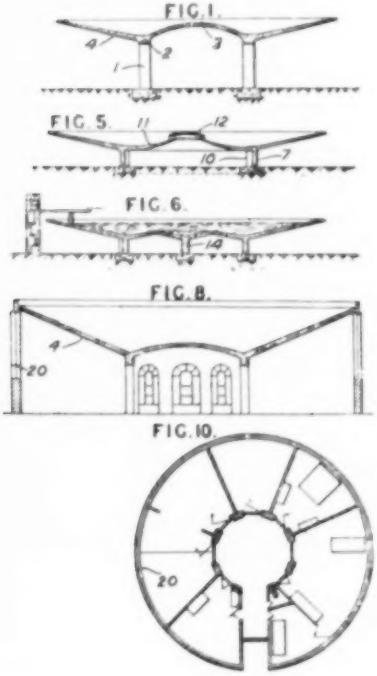
MANCHESTER: 7 OXFORD ROAD, MANCHESTER 1 (ARDWICK 1691) **GLASGOW**: 19 ST. VINCENT PLACE, GLASGOW, C.1 (CITY 6594)

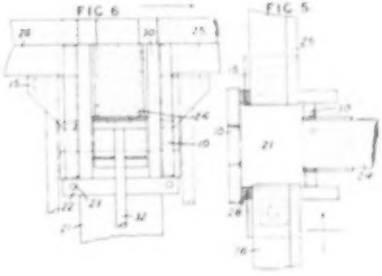
and the upper faces of the inclined edges (5) may be filled with a joint-filling composition after removal of the cap.—No. 521,480. A. Musall and Klocknerwerke Akt.-Ges. November 21, 1948.

Roofs for Circular Buildings.



A REINFORCED CONCRETE BUILDING having a large substantially saucer-shaped roof, comprises circumferentially arranged columns (1), *Fig.* 1, or a vertical cylinder supporting a circular crown (2) to which is attached a central part (3) of the roof, for example in the form of a cupola or cone and an annular overhung part (4) in the form of an inverted frustum of a cone or a spherical segment, the columns (1) receiving the vertical loads from the central and overhung parts of the roof. As shown in *Fig.* 5, the vertical cylinder (7) is provided with ribs (10) and the central part of the roof consists of a cone (11) surmounted by a cupola (12). A central support (14), *Fig.* 6, is provided in another modification and the roof forms a swimming bath. *Fig.* 8 shows a house in which the space beneath the overhung part (4) of the roof is enclosed by a glazed circular wall (20) which does not support the roof. The arrangement of the rooms is shown in *Fig.* 10.—No. 647,743. A. L. Hardy. Dec. 18, 1947.

Shutters for Junctions of Columns and Beams.



SHUTTERS for forming the junction of a column (21), Fig. 5, and one or more floor beams (24, 25, 26) of a frame structure comprise rectangular flanged panels (10) perforated uniformly along their flanges and over the panels and one or more beam-supporting angle-brackets (15) with uniformly-perforated side flanges, the panels and brackets being connected by bolts passing through the perforations to form a shutter supported by a frame clamped around the column (21) below the junction. Timber packing pieces (28, 30) or narrow perforated flanged panels through which the connecting bolts pass may be used to complete the shutter. The supporting frame consists of two timbers (22), *Fig.* 6, held against opposite sides of the column (21) by tie-bolts (23) and screw-adjusted props (32) are placed under the brackets (15) to support the beams (24, 25, 26). After the beams have been placed on the brackets (15), central beams (not shown) forming the shutters for the slab are placed on them, and when the continuity reinforcement for the beam and the reinforcement for the slab have been placed, the floor slab and the junction

of the column and beams may be concreted simultaneously. If the floor beams (24, 25, 26) are to be cast in situ, the shutter can be adapted to support the ends of the beam shutter.—No. 642,573. H. F. Rosevear and Sir R. McAlpine & Sons, Ltd. June 23, 1948.

[Publication of British patents has been delayed due to the war.]

New Bridge at Nottingham.

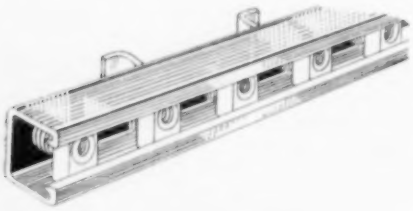
WORK has started on a bridge across the river Trent at Clifton, about two miles from the centre of Nottingham, for the Nottingham City Council. This bridge, which will have a 22-ft. carriageway, a 9-ft. cycle track, and a 6-ft. footpath, will form one-half of a future dual-carriageway bridge the overall width of which will be 46 ft. 3 in. The bridge will be on a skew of 24 deg. There will be three viaducts of about 40-ft. span in the approach from the north, the river will be crossed by a single span of 275 ft., and on the south there will be three viaducts of 90 ft. span.

Each of the northern viaducts will comprise sixteen precast H-beams 2 ft. 6 in. deep prestressed with steel bars, and a reinforced concrete deck slab; the spaces between the beams are to be covered by precast concrete planks to serve as permanent shuttering for the deck. The beams will be connected by precast transverse beams prestressed after assembly. Each of the south viaducts will consist of seven precast T-beams 5 ft. 6 in. deep and transverse beams prestressed with steel wires. The space between the flanges of the beams will be filled with in-situ concrete to form the deck slab, which will be prestressed transversely. The river span will consist of two balanced cantilevers with arms of 87 ft. 6 in. and 125 ft., and a central suspended span of 100 ft. The cantilevers and end spans will be cellular in cross section and will be cast in situ. The longer cantilevers will be cast on falsework, and it is proposed that the shorter cantilevers be constructed on travelling shuttering cantilevered from the work already concreted. The suspended span will consist of seven T-beams precast on the site and partially prestressed.

The work is under the direction of the City Engineer, Mr. R. M. Finch, O.B.E., in whose department the viaducts are being designed. The consulting engineers for the river span are Messrs. R. Travers Morgan & Partners. The contractors are Messrs. James Miller & Partners, Ltd.

Channels for Fixings to Concrete.

A STEEL channel, called Unistrut, is now available for insertion into concrete so that fixings can be quickly made where required. The channel is 1⅝ in. by 1⅝ in. with a returned lip on each flange. The channels are fixed to the concrete by lugs 1½ in. long on the back of the channel at 4-in. centres. Special nuts which are tightened against the lips of the channel by springs are supplied. These may be slid along the channel to the positions required for bolted connections. Fittings are available that allow the channels, without fixing lugs, to be formed into light frameworks. The sections are supplied singly, or welded together to form built-up sections where heavier loads have to be carried. Lengths of up to 20 ft. are supplied. The normal finish is stoved enamelling but hot-dip galvanized or unfinished sections are available. These fixings are supplied by Messrs. Sankey Sheldon, Ltd.



MISCELLANEOUS ADVERTISEMENTS.

Situations Wanted, 3d. a word: minimum, 7s. 6d. Situations Vacant, 4d. a word: minimum, 10s. Other miscellaneous advertisements, 4d. a word: 10s. minimum. Displayed advertisements, 30s. per column inch. Box number 1s. extra. The engagement of persons answering these advertisements is subject to the Notification of Vacancies Order, 1952.

Advertisements must reach this office by the 23rd of the month preceding publication.

SITUATIONS VACANT.

SITUATION VACANT. London consulting engineers, having extensive practice in reinforced concrete and structural steel, require a senior engineer with experience and personality. He must be a Corporate member of both the "Civils" and "Structurals," and preferably not more than 45 years old. Applicants must be capable of every type of design in ordinary and prestressed reinforced concrete. They must have the ability to supervise staff and to undertake independently direct contact with clients and work in progress. A commencing salary of £1500 per annum will be paid to a suitable applicant. The position is pensionable and would be subject to eventual transfer to partnership basis. Write the fullest information concerning professional and personal matters in confidence to Box 4125, Concrete and Constructional Engineering, 14 Dartmouth Street, London, S.W.1.

SITUATION VACANT. The Bowater Paper Corporation Limited have a vacancy for a Civil Engineering Design Draughtsman. Applicants should have either passed Sections A and B Examination of the Institution of Civil Engineers or have obtained exemption. Practical experience should include reinforced concrete and structural steelwork design, layout of railways, roads, drains, and sewers. Knowledge of surveying and setting-out an advantage but not essential. Contributory pension scheme. Applications will be treated confidentially. They should state details of age, education, training, experience, and salary required and be sent to the Chief Engineer, The Bowater Paper Corporation Ltd., Northfleet, Gravesend, Kent.

SITUATION VACANT. Engineer or research assistant wanted with concrete background for research department of large building concern to help organise and run quality control of concreting on building sites and in factories. Headquarters at Feltham. Five-days' week. Good pension scheme. Apply, with summary of experience and qualifications and stating salary required, to Box 4119, Concrete and Constructional Engineering, 14 Dartmouth Street, London, S.W.1.

SITUATIONS VACANT. Brian Colquhoun & Partners require a thoroughly experienced and competent civil and structural design engineer in their London office. Age 35–40 years with at least 15 years' experience in design office. Starting salary £950 per annum. Also several reinforced concrete designer-detailers with at least 10 years' experience in design office. Salary range £750 to £850 per annum. Applications in writing only, stating full details of experience and technical qualifications, to Brian Colquhoun & Partners, 18 Upper Grosvenor Street, London, W.1.

SITUATION VACANT. Reinforced concrete detailer, with some knowledge of design, required by progressive Midland firm. Opportunity to supervise structural section of drawing office. Interesting work and good prospects. Box 4115, Concrete and Constructional Engineering, 14 Dartmouth Street, London, S.W.1.

SITUATIONS VACANT. Draughtsmen, designers, or detailers in steel and/or reinforced concrete wanted by Birmingham consulting engineer. Good salaries are offered to those who will work and accept responsibility. Pension scheme. Box 4127, Concrete and Constructional Engineering, 14 Dartmouth Street, London, S.W.1.

SITUATION VACANT. Concrete formwork designer-draughtsman required by civil engineering contractors in Westminster. Apply in writing only, stating age, experience, and salary required, to Peter Lind & Co., Ltd., Romney House, Tufton Street, London, S.W.1.

REINFORCED CONCRETE ENGINEERS, DESIGNERS, & DRAUGHTSMEN, STRUCTURAL STEEL DESIGNERS

required in Manchester and Nottingham for interesting variety of prestressed and reinforced concrete buildings and industrial structures. Permanent positions, staff pension scheme. Apply, with full details of experience and education, to:

MATTHEWS & MUMBY, LTD., 129, Stockport Road, Manchester 12.

SITUATIONS VACANT. Twisteel Reinforcement, Ltd., have vacancies for designers and detailers in their London, Birmingham, and Manchester drawing offices. Apply, stating experience, to 43 Upper Grosvenor Street, London, W.1.

SITUATIONS VACANT. Reinforced concrete engineers require detailers and junior draughtsmen. Write, giving age, experience, and salary required, to Considere Constructions, Ltd., 72 Victoria Street, Westminster, S.W.1.

SITUATIONS VACANT. Reinforced concrete designer-draughtsmen and detailers required by Ashmore, Benson, Pease & Co., Stockton-on-Tees. Applicants should be fully experienced in either designing or detailing reinforced concrete structures, foundations, and other civil work. Pension scheme, technical library, sports facilities available, also company's flat. Apply, stating age, experience, etc., quoting reference D, to Staff Personnel Officer.

THE YORKSHIRE HENNEBIQUE CONTRACTING CO. LTD.

(Established 1904)

require in their new HEAD OFFICE at HENNEBIQUE HOUSE, THE MOUNT, YORK, a

CIVIL ENGINEERING ESTIMATOR

The post should prove permanent to the accepted applicant, who preferably should be a qualified Civil Engineer (age 35/45) of adequate experience in skilled civil engineering works with good firms.

Application, giving full details of experience, references, salary expected, etc., to be addressed to

D. W. JONES, B.Sc., M.I.C.E., Managing Director.

They will be treated confidentially.

The usual scheme of superannuation is available, and assistance may be given, if required, regarding accommodation.

SITUATIONS VACANT. Experienced reinforced concrete detailers required for permanent design staff in London office. Salary according to experience. Five-days' week. Apply to A. V. Cox, Planning Department, George Wimpey & Co., Ltd., 27 Hammersmith Grove, London, W.6.

SITUATION VACANT. Well-known precast concrete manufacturers in South Wales have vacancy for works manager with first-class qualifications and experience. Knowledge of prestressed products an advantage. Write in full detail with copies only of testimonials to Box 4126, Concrete and Constructional Engineering, 14 Dartmouth Street, London, S.W.1.

SITUATION VACANT. Experienced general engineering draughtsman, preferably with a knowledge of reinforced concrete design. This is a superannuated post with excellent opportunities for progress. Write, stating age, qualifications, and experience, to the Staffing Officer, The Stanton Ironworks Co., Ltd., near Nottingham

(*Continued on page* lxiv.)

MISCELLANEOUS ADVERTISEMENTS.

(*continued from p.* lxiii.)

NORTH THAMES GAS BOARD

A SENIOR DRAUGHTSMAN, for the design and detailing of reinforced concrete structures and general engineering work, is required in the Chief Engineer's Department at WESTMINSTER.

Candidates should preferably be Corporate Members of the Institutions of Civil or Structural Engineers. Starting salary within the range £745 to £895 per annum, according to age, qualifications and experience. The successful candidate will be required to join the Staff Pension Scheme.

Applications, giving age and full particulars, should be sent to the Staff Controller, North Thames Gas Board, 30, Kensington Church Street, London, W.8, quoting reference 666/197.

SITUATIONS VACANT. Draughtsmen. Mechanical or structural designers and detailers wanted, willing to adapt their skill and ideas to work on special structures in the building trade. Initiative and inventive qualities will have very opportunity to be exercised. A successful applicant will hold a progressive position and participate in a team bonus scheme. This opportunity due to staff promotions overseas. Write to Secretary to the Managing Director, Acrow (Engineers), Ltd., 8 South Wharf, Paddington, London, W.2.

SITUATIONS VACANT. The British Reinforced Concrete Engineering Co., Ltd., have vacancies for reinforced concrete designers and detailers, with experience, in their Stafford, London, Liverpool, Bristol, Newcastle-on-Tyne, and Glasgow offices. Staff pension scheme and five-days' week. Apply in writing to Chief Engineer, Stafford.

SITUATIONS VACANT. AIR MINISTRY Works Designs Branch requires, in London, structural engineering designer/draughtsmen for reinforced concrete or structural steelwork with sound technical training and several years' varied experience in design/detailing of (*a*) Reinforced concrete construction for all types of buildings, or (*b*) steel-framed sheds, warehouses and similar buildings. Salaries up to £810 per annum, starting pay dependent upon age, qualifications and experience. Extra-duty allowance or overtime payable. Posts non-pensionable with long-term possibilities. Natural-born British subjects only. Write, stating age, qualifications, employment details, including type of work done, to Ministry of Labour, 236 Walworth Road, London, S.E.17, quoting Order 82/BA.

SITUATIONS VACANT. Design assistants required by Westminster consultant. Two grades available (1) Those in progress with H.N.C. studies. (2) A.M.I.C.E qualifications. Remuneration will be based on technical education and experience, which please indicate in your application to Box 4128, Concrete and Constructional Engineering, 14 Dartmouth Street, London, S.W.1.

SITUATION VACANT. Research engineer required by the Research and Development Division of the Cement and Concrete Association, near Slough, to work on concrete materials and methods of construction. Preference given to candidates about 27 years of age with Honours Degree in Engineering and one or two years' practical experience. Salary according to qualifications and experience. Opportunities for obtaining higher degrees and specialised knowledge. Write, with full particulars, to the Secretary, Cement and Concrete Association, 52 Grosvenor Gardens, London, S.W.1.

SITUATIONS VACANT. Reinforced concrete designer-detailers and detailers required by progressive consultants engaged on varied interesting work at home and abroad. Write, giving full details with salary required, to Hunter & Dunn, 34 Smith Square, London, S.W.1.

SITUATION VACANT. Shuttering engineer experienced in both design and practical application, required by leading steel shuttering manufacturers for design work and visits to contractors in the greater London area on technical matters. Good prospects for right man. Write Box 4129, Concrete and Constructional Engineering, 14 Dartmouth Street, London, S.W.1.

SITUATION VACANT. Structural engineer required by civil engineering contractors in London, S.W.3, for the design of reinforced concrete structures. Applicants need not have specialised in concrete design but should be familiar with normal methods of structural analysis. Permanent position. Salary in accordance with qualifications and experience. Please reply in own handwriting to Box 4130, Concrete and Constructional Engineering, 14 Dartmouth Street, London, S.W.1.

SITUATION VACANT. Detailer-draughtsman required for varied reinforced concrete work. Permanent, progressive, and superannuated post. 36½ hours' week. Alternate Saturdays. Telephone for appointment (Mr. Disney), the Rom River Co., Ltd., Euston 7814.

SITUATIONS VACANT. Experienced reinforced concrete designers and detailers required by consulting engineers in their Sunbury office. Five-days' week. Permanent position, good salary and prospects. Apply, stating age and experience, to J. H. Coombs & Partners, Thames Corner, Sunbury-on-Thames.

SITUATIONS VACANT. Reinforced concrete detailers required, with sound knowledge and experience, for permanent positions. Five-days' week. Pension scheme. Apply by letter to E. J. Cook & Co. (Engineers), Ltd., Lynton House, 54 South Side, Clapham Common, London, S.W.4.

SITUATIONS VACANT. Reinforced concrete designers and draughtsmen required by reinforcement manufacturers for their Bristol office. Permanent pensionable posts with good prospects to men with sound experience. Box 4131, Concrete and Constructional Engineering, 14 Dartmouth Street, London, S.W.1.

SITUATIONS VACANT. Kaylor & Pick, consulting engineers, require in their London office designers and detailers for reinforced concrete work. Five-days' week, permanent positions. Apply to 42 Ferncroft Avenue, London, N.W.3.

SITUATIONS VACANT. Senior and assistant designer-draughtsmen required by company in Westminster specialising in reinforced concrete frames and floors. Permanent progressive positions. Commencing salary £800 and £600 per annum according to ability. Superannuation scheme available. Alternate Saturdays. All replies strictly confidential. Box 4132, Concrete and Constructional Engineering, 14 Dartmouth Street, London, S.W.1.

SITUATIONS VACANT. Civil and structural engineering assistants experienced in reinforced concrete and structural steel required. Knowledge of design will be an advantage but not essential, depending on positions. The work is varied and offers scope for initiative. Five-days' week. Pension scheme. Good salaries will be offered to suitable applicants, who should state experience and salary required to Engineering Department, Farmer & Dark, Romney House, Tufton Street, London, S.W.1.

SITUATION VACANT. Experienced designer-draughtsman required for London head office of old-established reinforced concrete engineers specialising in hollow-tile type floor construction. Applicants must be capable of taking charge of and supervising medium-size drawing office, and possess knowledge of current by-laws and codes of practice. Permanent, progressive, and pensionable post. Write fully qualifications, experience, and salary required, to Box 4133, Concrete and Constructional Engineering, 14 Dartmouth Street, London, S.W.1.

SITUATION VACANT. Designer-detailer required for precast and in-situ structures. Knowledge of moment-distribution and pitched-roof calculations desirable. House available. Temporary employment in London followed by permanent position in Hemel Hempstead. Good salary, bonus, and pension scheme. Travelling expenses paid. Telephone Victoria 1881 or write for an interview. The London Ferro-Concrete Co., Ltd., 247/249 Vauxhall Bridge Road, London, S.W.1.

SITUATIONS VACANT. Detailing draughtsmen required for interesting specialist work. Good salary and prospects. Bonus scheme. Five-days' week. Write giving full particulars, age, and salary required, to Lenscrete, Ltd., 339 Queenstown Road, London, S.W.8.

SITUATION VACANT. Reinforced concrete detailer-draughtsman required by Midland firm for interesting precast and in-situ work. Good salary and prospects. Write giving full particulars, age, and salary required, to Box 4134, Concrete and Constructional Engineering, 14 Dartmouth Street, London, S.W.1.

SITUATIONS VACANT. Assistant engineers wanted by Newcastle civil engineering contractors. Able to organise reinforced concrete works at site under direction of firm's senior civil engineers. Starting salary £800 to £1,000 per annum, plus bonus on profits and pension scheme. Car provided. Preference for A.M.I.C.E., age

about 30, but any candidate with proved experience of site management will be considered. Apply in writing, stating age, qualifications, previous experience, and salary required, to MANAGER, BRIMS & CO., LTD., Pandon Buildings, Newcastle-upon-Tyne, 1.

SITUATION VACANT. Designer-detailer-draughtsman wanted for professional engineer's office, London (own staff notified). Mainly reinforced and prestressed concrete work. Box 4135, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

SITUATIONS VACANT. Reinforced concrete designer-detailers wanted by British company in Kampala (Uganda) and Dar-es-Salaam (Tanganyika). Candidates should have at least five years' experience. Salary according to ability and experience. Free air passages. Two months' paid home leave by air each 2½ years. Bonus and pension schemes. Applications will be treated in strict confidence. Write Box FE/189, 95 Bishopsgate, London, E.C.2.

LONDON COUNTY COUNCIL.

Architect's Department.

Vacancies for Engineering Assistants (up to £739 10s.) and Engineer Grade III (up to £892 10s.) in the Structural Engineering Division. Work includes steelwork and reinforced concrete design and detailing for Council's buildings. Particulars and application forms, returnable by 20th April, 1955, from Architect (AR/EK/SE/3), The County Hall, London, S.E.1 (271).

BOLTON AND DISTRICT SEWERAGE BOARD.

RINGLEY FOLD DISPOSAL WORKS.

Applications are invited for the appointment of a Reinforced Concrete Engineer in connection with the proposed Sewage Disposal Works at Ringley Fold.

Applicants should possess a University Degree in Engineering and/or be Corporate Members of the Institution of Structural or Civil Engineers. Previous experience in the design of Reinforced Concrete Tanks and similar structures is essential, and experience on Sewage Disposal Plant Design would be an added advantage.

The salary offered is within the Grade APTV. of the National Scale of Salaries (£750 to £900). The commencing salary will be fixed according to qualifications and experience.

The appointment will be for a period of at least five years, and is subject to the provisions of the Local Government Superannuation Acts and to the passing of a medical examination.

Further particulars and forms of application may be obtained from the undersigned, to whom they should be returned not later than 21st March, 1955.

PHILIP S. RENNISON,
Clerk of the Board.

Town Hall, Bolton.

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(Continued from p. lxv.)

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Required for expanding office of Consulting Engineers engaged on varied schemes in Reinforced Concrete and Structural Steel construction. Offering permanent posts with :
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SITUATION WANTED. M.I.Struct.E. accustomed to executive responsibility and experienced in the professional and commercial fields of structural and civil engineering and building, especially reinforced and precast concrete, seeks senior post at home or abroad. Box 4124, Concrete and Constructional Engineering, 14 Dartmouth Street, London, S.W.1.

DESIGN WORK WANTED. Reinforced concrete designer-draughtsman with 20 years' experience in the design of reinforced concrete structures, willing to assist consulting engineers, undertakes to prepare complete designs, calculations and working drawings. Excellent references. Moderate fee. Box 4117, Concrete and Constructional Engineering, 14 Dartmouth Street, London, S.W.1.

FOR SALE.

FOR SALE. Steel buildings, small and large, home or abroad, 30 ft. up to 200 ft. wide. Large clear high spans with or without runways, etc., for lifting loads. Bellman Hangars, Ltd., 21 Hobart House, Grosvenor Place, London, S.W.1.

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FOR HIRE. Lattice steel erection masts (light and heavy), 30 ft. to 150 ft. high, for immediate hire. Bellman's, 21 Hobart House, Grosvenor Place, London, S.W.1.

DATA FOR PRICING REINFORCED CONCRETE.

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(Delivered in London area.)

Aggregates (per cu. yd.).—Washed sand, 23*s.* 8*d.* Clean shingle : ¾ in., 20*s.* ; ½ in., 22*s.* 7*d.* Pit ballast, 23*s.* 1*d.*

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Snowcrete, £12 17*s.*, inc. paper bags.
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Shuttering.—1" and 1½" deal sawn shuttering boards, £95–£100 per standard.

Reinforcement.—Mild steel bars, B.S. 785 (per cwt.) ; ¼ in. to 2½ in., 43*s.* 3*d.* ; ⅜ in. to ½ in., 45*s.* ; ⅝ in., 45*s.* 9*d.* ; ¾ in., 47*s.* 3*d.*

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(Contracts up to £5000. Including 10 per cent. profit.)

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Foundations, 2*s.* 5½*d.* per cu. ft. Columns, 3*s.* 4½*d.* per cu. ft. Beams, 3*s.* 1½*d.* per cu. ft. Floor slabs, 4 in. thick, 8*s.* 10½*d.* per sq. yd. ; Do., 5 in., 11*s.* 2*d.* ; Do., 6 in., 12*s.* 9½*d.* ; Do., 7 in., 15*s.* Walls 6 in. thick, 14*s.* 3*d.* per sq. yd. Add for hoisting above ground level, 3*s.* 8*d.* per cu. yd. Add for rapid-hardening Portland cement, 2*s.* 6*d.* per cu. yd.
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Small fillets to form chamfers, 6*d.* per lin. ft.

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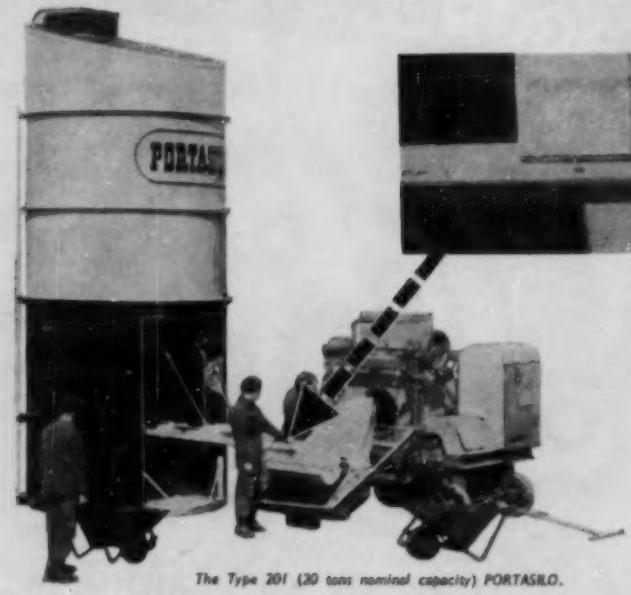

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The system eliminates:

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